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Compressed Air Magazine

Vol. XXIX, No. XI London New York Paris 35 Cents a Copy

NOVEMBER, 1924

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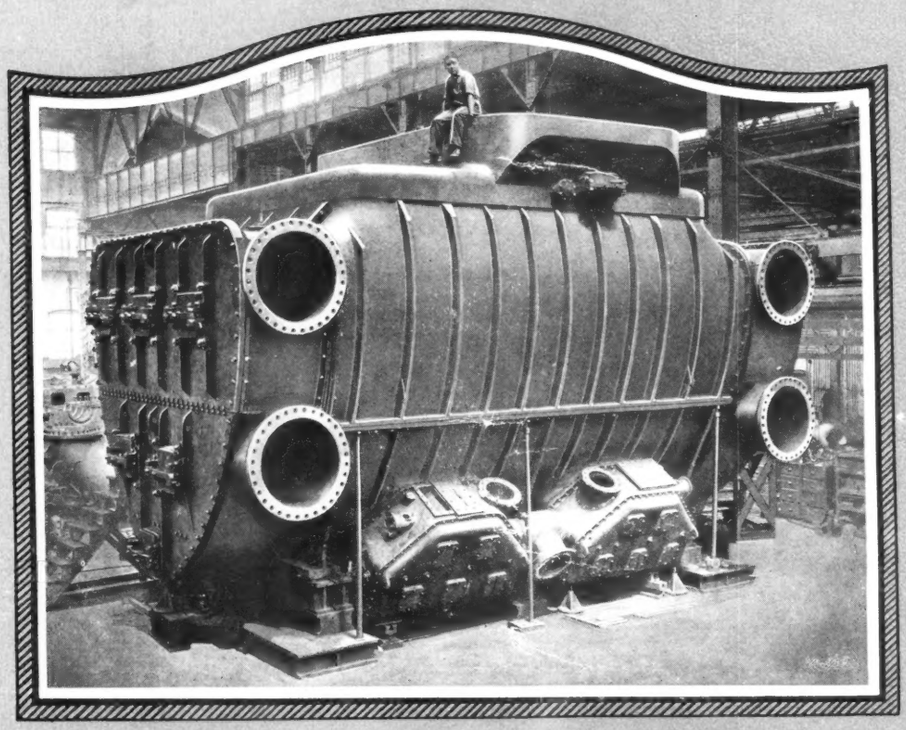

GIGANTIC SINGLE-PASS SURFACE CONDENSER BUILT TO SERVE A 35,000-KILOWATT TURBO-GENERATOR.

How Trunk-Line Locomotives are Kept Fit For Their Tasks
R. G. Skerrett

Extending Electrical Conduits Under Difficult Conditions
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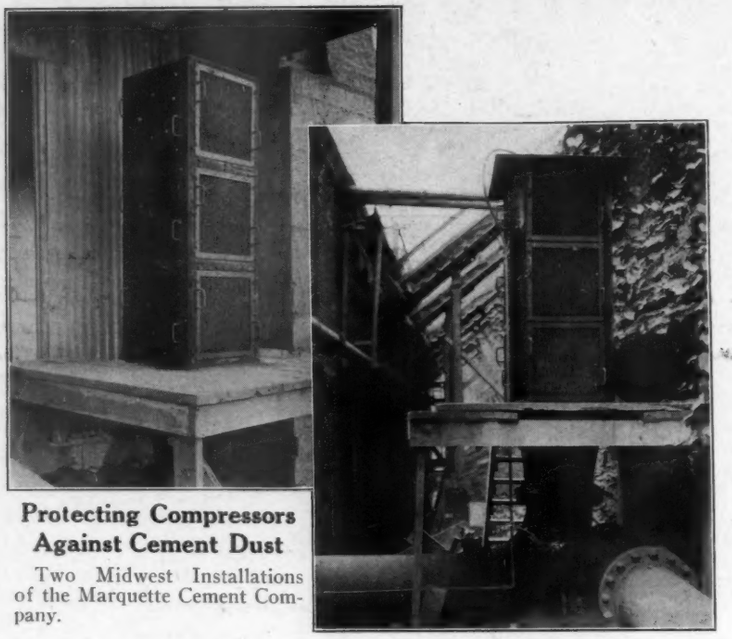

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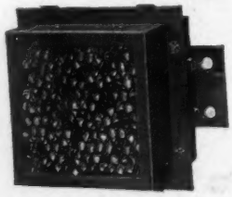

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VOL. XXIX, NO. XI

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NOVEMBER, 1924

How Trunk-Line Locomotives Are Kept Fit For Their Many Tasks

This is Revealed by the Activities in the Repair Shops of an Important Railroad

By ROBERT G. SKERRETT

REVENUE-YIELDING freight is now being loaded at the rate of nearly 1,000,000 cars a week, and the crest of this growing tide of merchandise in transit has not yet been reached. This performance is the best proof that business is improving and that our industrial life as a whole is gaining steadily in vigor.

To the man in the street, the fact that so many freight cars are filled to capacity every seven days is not especially illuminating because his grasp of the interrelated activities of the entire country is usually extremely limited. This is not said by way of disparagement, but merely to emphasize that his daily work commonly narrows his range of vision and the scope of his interests. Just the same, it would be to his advantage if he took pains to ascertain how much the railroads of the United States contribute to his creature comfort and convenience.

Not long ago, Robert S. Binkerd, Vice-chairman of the Committee on Public Relations of the Eastern Railroads, stated that "The freight service of the American railroads in 1923 was equivalent to hauling over 4,100 tons of freight one mile for every man, woman, and child in the country." He further disclosed that we are about ten times more dependent upon railroad transportation than are the peoples of civilized Europe. And he stressed the fact that we are today three times more dependent upon our railroads than we were but twenty years back.

Railroad efficiency, therefore, concerns each and all of us, for how could raw and finished commodities—not to mention passengers—be carried from one end of the land to the other in the absence of railways? According to the latest available figures, our Class I railroads have a total of 253,708 miles of route within the continental limits of the country; and over this network of rails, for the convenience of the public, are drawn to and fro more than 2,317,600 freight cars and a matter of fully 54,000 passenger cars. To haul these cars in transit and to shift them about at terminal points there are required an aggregation of 64,594 locomotives; and nearly 60 per cent. of these engines are in freight service. These details are dwelt upon merely to bring home to the reader the manner and the magnitude of the work performed for the general good by these common carriers.

WHAT OUR arteries are to our bodies the trunk-line railways are to the nation as a whole. Both the arteries and the railroads are essential features of vitally necessary systems of transportation: one carrying blood to nourish and to stimulate the physique and the other moving essential commodities or materials which make for the industrial, the economic, and the social well-being of every part of this great land of ours.

The muscular power of the heart is the medium by which the blood is sent coursing through the veins and the arteries, while the laden trains of our railways are drawn over the tracks by the sturdy might of ponderous fabrications of steel and iron and brass.

How these "iron horses," as they are picturesquely called, are kept fit for their manifold tasks is but little known by the general public. The purpose of this article is to give some idea of the work involved in the up-keep of the thousands of locomotives in service and to describe wherein compressed air helps to this end.

It can be readily understood that the thousands of locomotives enumerated represent a tremendous amount of mechanical energy; and these "iron horses" must be looked after ceaselessly so that they will be in a condition to do their work well and safely. The majority of us are unaware of it, but even the biggest of our locomotives call for the nicest kind of handling to get the most out of them. Robust as they are, they are all too apt to develop weaknesses or defects in service, and the likelihood of this increases directly with the severity of the duty imposed upon them.

The disposition of the average traveler, for instance, is to give but casual heed to the machine which is pulling his train at express speed up hill and down dale, over straight stretches of road, and around sharp or sweeping curves in the course of a journey that is marked by punctuality at every station stop. It seldom occurs to him to analyze what that performance means. It does not dawn on him that changing grades and altering lines of travel put sudden and at times very severe stresses upon rapidly moving masses of metal which depend upon perfect alignment to insure their efficient functioning. Unavoidable flexing induces wear that must be watched lest something break when least expected. A broken pin, a fractured side rod may let loose on a racing locomotive a piece of mechanism capable of dealing titantic blows of sufficient force to wreck either the engine or the underlying track—in either case inviting a disaster.

Only by eternal vigilance on the part of the man at the throttle as well as on the part of the "hostlers" and inspectors in the roundhouse is it possible to detect the first signs of significant wear or insipient failure. And, further, only by the thoroughness of the inspection and the overhauling which the locomotive receives in the repair shops is it practicable for the railroads to maintain the schedules they do day and night, day in and

Left—Removing rough spots from the pedestal of a locomotive frame with an air-driven grinder. Right—Putting the finishing touches on brasses with a pneumatic grinder.

day out, the year through. Not only that, but any neglect in this respect would inevitably cut down the operative efficiency of the locomotive and add accordingly to the cost of running it. Therefore, apart from the question of safety, there is a very practical reason for seeing to it that the engines are kept in prime condition. Back in 1907, the average purchasing price of a heavy freight locomotive was in the neighborhood of $16,250. At the present time, such an engine would cost fully $53,500, while the modern large locomotive has gone up in price from $75,000 to $100,000.

As a result of years of experience, the Interstate Commerce Commission has drafted exacting requirements regarding the up-keep of locomotives in trunk-line service, and specifies just how repairs shall be made to meet acceptable standards. Interesting as it might be to describe in detail some of these requirements, space does not permit. It will suffice if we state that the purpose of these regulations is to promote both safety and efficiency. How well the railroads have responded is evidenced by the economies which they have brought about latterly and by what they are doing in the way of moving more tons in each car, by hauling more cars in each train, and by getting a greater mileage daily out of each locomotive—in short, more transportation for each ton of fuel burned.

It was not so long ago that the average distance covered by freight cars in the course of 24 hours of travel did not exceed 20 miles. The average in 1923 was 27.9 miles a day; and the record has now reached 30.7 miles. The United States Department of Commerce, speaking of the carriage of freight, has stated that the "time in transit was 50 per cent. longer in 1922 than in 1923." A goodly share of this betterment is traceable to the work of the men in the locomotive repair shops.

And now let us see how this phase of railroading is dealt with in one of the 403 plants engaged in this kind of service. The shops at McKees Rocks, Pa., of the Pittsburgh & Lake Erie Railroad are an excellent example of up-to-dateness in equipment and in practice. These shops take care of all the locomotives on the line; and each month they are busy in putting through anywhere from 20 to 25 heavy repair jobs—not to mention numerous other ones of a lighter or less troublesome nature. A typical example of a heavy repair job is that of overhauling a boiler; and to accomplish this in an approved manner takes substantially 25 working days. This is not to be wondered at when one is made aware of the rather complex get-up of the steam generator with its fire-box and its hundreds of flues or tubes through which the flames and hot gases pass stackward while transforming the enveloping water into steam at a maximum pressure of 210 pounds.

This handy tool is here used to grind a main-rod strap.

In the erecting shop at McKees Rocks there are eighteen working "pits" over which locomotives can be placed to permit any part of the engines to be stripped, examined, and repaired. While a locomotive is expected to undergo overhauling on an average every sixteen months, still the interval between "shoppings" is determined by the class to which each locomotive belongs and by the mileage run during each period of active service. Again, conditions may compel more frequent returns to the shops. For example, because of seasonal taint of the water or the presence in it of certain matter, the boiler feed may act so inju-

riously on the tubes as to render them unfit for further service in so short a time as three months. Then the damaged tubes must be cut out and new ones supplied. One of our illustrations gives a good idea of the sizes and the multiplicity of these tubes; and even the uninitiated can realize what it means to replace 300 or more of them and to secure them in place.

This work requires that each slightly projecting end of a tube shall first be expanded to make it fit snugly the hole in the associate flue sheet and that the "belled" metal be then rolled over outwardly or "beaded," as it is sometimes termed, to draw the tube watertight against the flue sheet. Air hammers, or chippers and calkers, together with pneumatic drills, perform these operations when equipped with tools especially designed for the service. With hundreds of flues to be put in a single locomotive, and with each tube to be twice expanded and rolled, the aid rendered by compressed air in this important work should be obvious.

Formerly, when it became necessary to remove boiler tubes, it was customary to do this work with an air-driven hammer or calking tool—the entire job of cutting out the big 5½-inch flues and the more numerous 2-inch flues taking a man anywhere from 12 to 14 hours. Today, the operation is performed by what is known as a flue-cutting machine, which is driven by an air drill. With this tool one man can cut 339 tubes in the course of only 6 hours. The pneumatic cutter severs a tube while making 1¼ turns; and the flue can then be driven out through the front tube sheet of the boiler.

Once a year the boiler of every locomotive must undergo a hydrostatic test at a pressure 25 per cent. above the rated working pressure of that steam generator; and, as far as possible, an internal examination is made of the boiler after this test. Further, at the end of every five years, the boiler of each locomotive has to be subjected to an external as well as an internal examination, and enough of the flues must then be withdrawn to permit the inspection of the main body or "barrel" of the boiler. The pneumatic flue cutter enables this to be accomplished with the least damage to the tubes—the same being true when the flues, for the most part structurally sound, are removed on any other account. The tubes, so shortened, can be used again when they are sufficiently lengthened by having welded to them a few inches of new tubing.

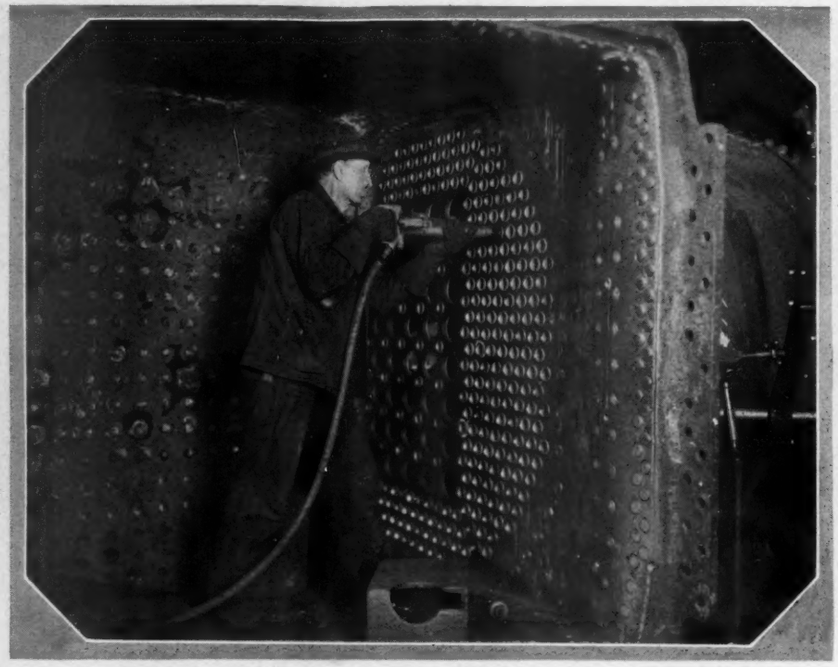
In the boiler shop at McKees Rocks this is done in the following manner: The tube and the new length are heated in an oil furnace operated by compressed air; next they are run into a revolving mandrel; and then, while still red hot, they are swedged by a small mechanical hammer. By means of these facilities, tubes that have been cut out of the flue sheets can be repeatedly made fit for service—in fact their effective life may run from ten to twelve years.

Probably the hardest used part of a locomotive boiler is the fire-box or what the layman would call the furnace. In it fuel is burned under conditions that induce heat enough to generate steam at a rate fast enough to furnish motive energy to the pistons which, in turn, give motion to the rapidly revolving driving wheels. The inner walls of the fire-box

Fig. 1—Air-driven jam riveter back driving the head end of a rivet against a regular Ingersoll-Rand riveter. Fig. 2—Here we see some of the work of the pneumatic flue-cutting machine. Fig. 3—Tapping for stay bolts in a locomotive boiler with an air-operated drill. Fig. 4—Air bucker-up and pneumatic riveter at work while a third man calks the mud-ring of a locomotive fire-box.

are surrounded by parallel walls of steel, thus leaving an intervening space of a few inches. When ready for service this space, known as the water-leg, is filled with water so that the first heat of the burning fuel is brought in contact with that water before the flame and gases travel forward through the flues to the smokestack. To bind the fire-box to the enveloping walls, the locomotive builder employs a large number of what are called stay bolts.

Some of these bolts are screwed into both the inner and the outer sheets of the fire-box. Others, called flexible bolts, are screwed into the inner sheet, while their outer ends rest in sockets or sleeves which are screwed into the outer sheet. A cap is then screwed onto each sleeve. After that, the inner end of every bolt is upset or headed with an air hammer to secure it in place and to seal it tight against steam pressure. As might be expected, all threaded holes for stay bolts are tapped by means of pneumatic drills; and air-driven drills are also used to screw the bolts and sleeves into position as well as to screw on the caps. Further, after the bolts are in place, a tell-tale hole is drilled in the center of each from the outside. This is a safety precaution prescribed by the Government authorities, and is designed to betray any weakening of the bolts where leakage will be readily seen.

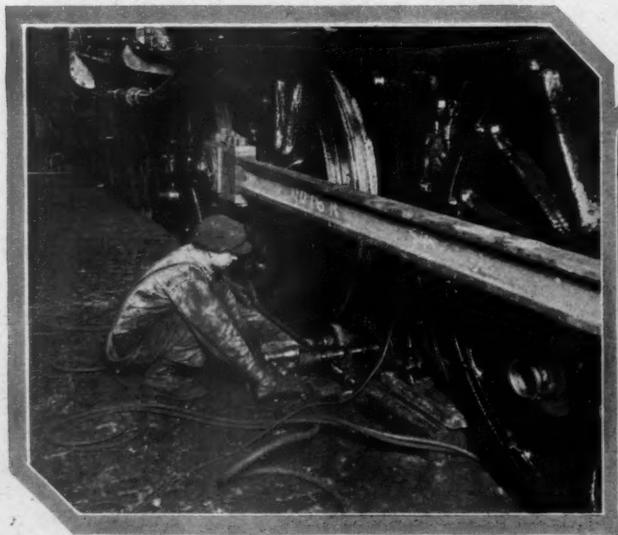


Replacing boiler tubes. Workman with an air hammer engaged in expanding the tubes to make them fit snugly in the holes of the flue sheet.

Because stay bolts are subjected to severe stresses, and as their structural responsibility is a heavy one, the Interstate Commerce Commission requires that the sleeves of all flexible stay bolts must be removed every two years to permit the examination of the bolts. In fact, this may be ordered whenever an inspector deems it necessary. As explained, the different operations recited are expedited by means of air-driven drills, hammers, and calking and chipping tools. The bottom of the water-leg is sealed by what is termed a mud-ring, and two of our pictures show boiler-makers riveting up the mud-ring in one case and calking it in the other. The reader will have learned enough to understand that the construction of a locomotive fire-box is a tedious and an exacting job, and the work would be much harder and far more protracted if it were not for the pneumatic hammer, the jam riveter, the air bucker-up, and the straight-away and close-quarter drills—both of them operated by compressed air.

It will not be possible for us to mention more than a few of the outstanding things that have to be done to a locomotive when it is sent to the shops for general overhauling. It will be readily appreciated that the high speeds now maintained require that every engine shall be examined thoroughly and with great care when it arrives for this rehabilitation. Not a bolt or a nut is overlooked. All wearing surfaces are scrutinized by trained eyes, and nothing is taken for granted. The locomotive engineer and the inspectors collaborate to make sure doubly sure. When stripped during this process, a locomotive but little resembles the splendid, self-sufficient-appearing machine with which the traveling public is familiar. Figuratively speaking, only its bare bones or framework are left in place when the stripping is completed.

A modern heavy freight or passenger locomotive is made up of something like 3,000 separate parts or pieces—not counting rivets, bolts, etc., and the condition of each of these must be ascertained. All that are found unsatisfac-



Left—Here the air-driven drill is used as a motor to slowly revolve the driving wheels while a shopman is setting the valves which regulate the flow of steam to and from the cylinders of a locomotive.

Right—Drilling tell-tale holes in stay bolts by a pneumatic drill. This is a precautionary measure prescribed by the Government.

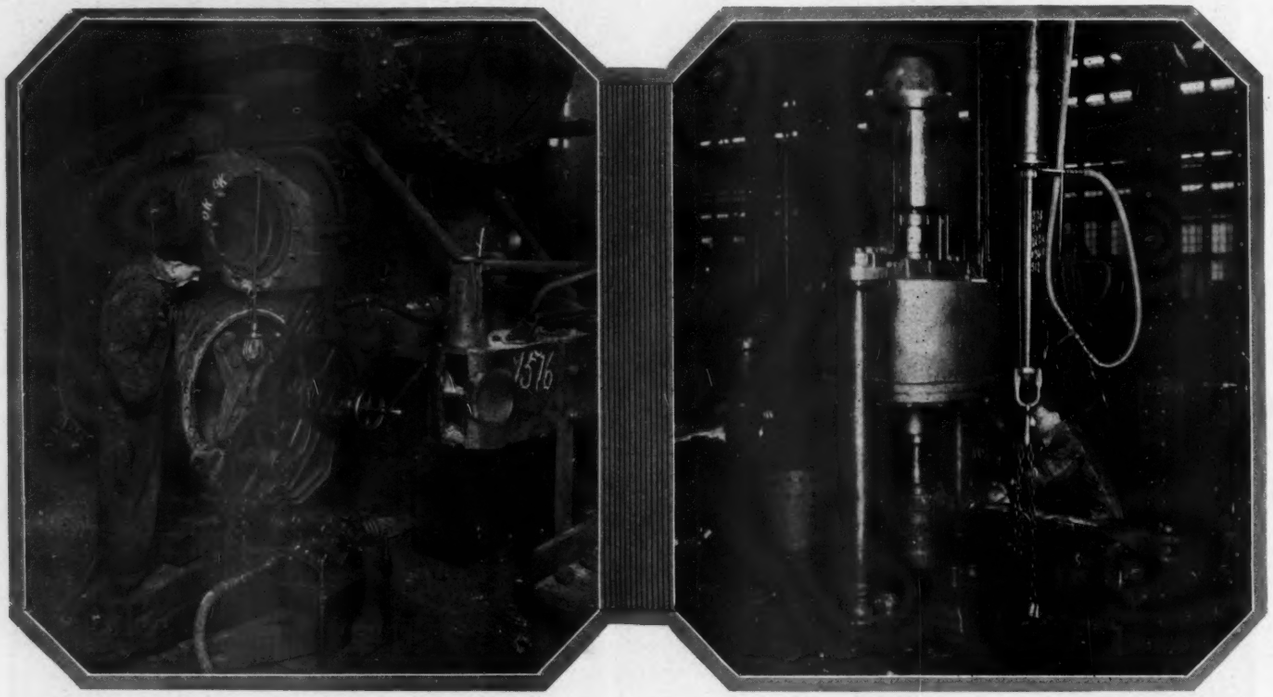
Fig. 1—Pneumatically operated machine for shortening main rods, side rods, drawbars, etc.
Fig. 2—Air-driven bulldozer employed for heading rivets and bolts.
Fig. 3—Swedging new sections on old boiler tubes to make them fit for re-use.
Fig. 4—Air-operated press bending end-gate hinges for composite cars.
Fig. 5—Type of furnace extensively used in the blacksmith shop at the McKees Rocks plant.

tory must be replaced or repaired. On certain big so-called superheater "sport" locomotives, of which the line has ten, there are nine miles of piping on the exterior of each of them. It is important that every joint and every connection of this piping shall be tight. The largest of the engines handled at the McKees Rocks shops are of 130 tons in weight; but, no matter what the type, the operating department of the road demands that the locomotives shall be made ready for use again with all practicable speed; and to this end it is indispensable that the repair plants be equipped with every available tool that will enable the shopmen to do their work well and in the shortest time. Let us mention a few examples of equipment that help to accomplish this.

Everyone realizes that the cylinders of a locomotive are inevitably subjected to much wear because of the rapid to-and-fro movement of the driving pistons. This wear is uneven and tends to deform the cylinder bore by making it more or less elliptical. Therefore, it is customary to rebore the cylinders during overhauling. At McKees Rocks the operation is performed by a boring bar which is driven, through suitable gearing by an air drill. Thus, a 26½-inch cylinder can be rebored in the course of 7 hours. Besides saving several days in time, the machine cut is a heavier one than that which can be made by hand, and the truing process is, accordingly, a more thorough one.

The steam cylinders are bolted together and to the framework of the locomotive by large bolts fitted into accurately reamed holes. In making repairs, all loose bolts are removed, but before new bolts are put in place the holes are again carefully reamed. The heavy reamers used for this purpose are driven by air drills at a great saving of time, as compared with hand methods.

Another interesting and kindred employment of the air drill as a motor is that of using the drill to revolve the driving wheels slowly while shopmen are engaged in setting the valves which regulate the flow of steam to and from the cylinders of a locomotive. The adjustment of these valves is a matter of much nicety, for upon their proper setting depends the effective and economical functioning of the "iron horse." The pneumatic drill, in the manner mentioned and as shown by one of our illustrations, permits the machinists to set the valves, to watch their movements, and to do these essential things without recourse to steam.



Left—An air drill furnishing the motive power to turn a boring bar boring out a locomotive cylinder. Right—Pressing a side-rod bushing into place by means of an air-operated hydraulic press.

For grinding all rough surfaces, for grinding clearances for brasses or bearings, and generally for smoothing out inequalities on metal parts, air-driven grinders are adaptable labor and time-saving tools. They obviate recourse to handwork or to putting the piece through a planer or a milling machine. A compressed air operated machine in the blacksmith shop makes it feasible to shorten main rods, side rods, and draw bars so that they can be made fit for re-use. The same apparatus can be employed for heavy bending and for the testing of powerful springs which form part of the equipment of locomotives. Again, an air-driven bulldozer serves to head heavy rivets and bolts which are needed in the fabrication of the big "iron horses." Fuel oil, sprayed by compressed air, produces the flaming jets that heat and expand the worn tires of driving wheels so they can be removed expeditiously. In this way a tire can be heated sufficiently in from fifteen to twenty minutes so that it can be readily forced off.

Side rods, main rods, air pumps, and various other features that have become coated with dirt in service are cleaned in tanks containing an alkaline mixture which is heated by steam and agitated by compressed air. This procedure shortens the time in which these parts can be cleansed and made ready for inspection and possible repair. Tube sheets and flues are sometimes sandblasted to rid them of scale or foreign matter before the tubes are put in place and welded to the tube sheets. This is not the common procedure, however. The usual practice is to clean the flues with a flue cleaner—which may be a special air-operated device, while flue sheets are cleaned by going over them with a cleaning tool and by rapping them as well with an air hammer. In this way, dirt and scale are pounded loose from the metal surfaces and then swept out with a broom. In the roundhouse it is the custom to blow out the flues with compressed air whenever a locomotive arrives there, and this service naturally requires a good deal of compressed air. In the final finishing of the overhauled locomotive, the painting of everything but the cab is done by means of the pneumatic spray. As the surfaces to be covered are somewhat expansive, decidedly irregular, and often not easy of access, spray painting has greatly simplified this essential work and made it possible to effect substantial economies.

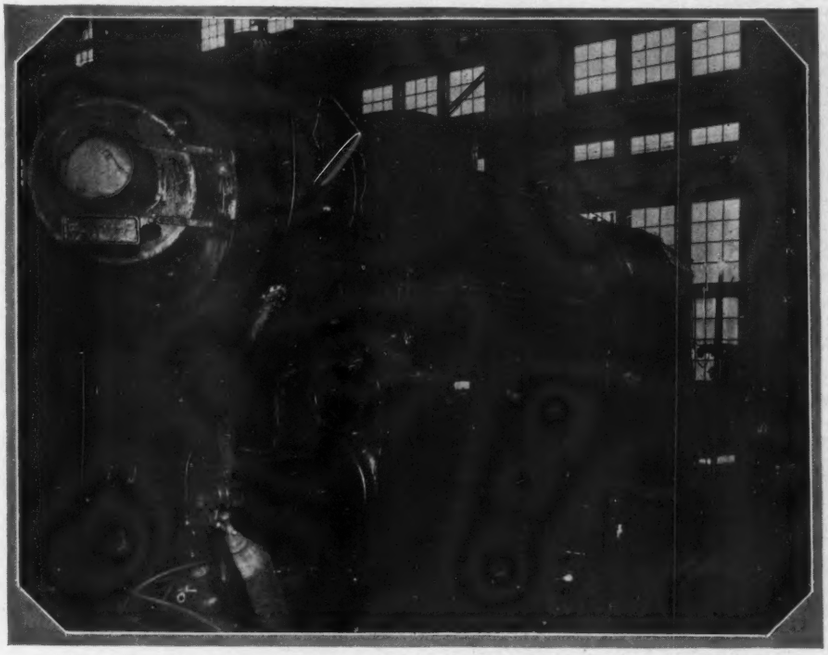
There are a number of other directions in which compressed air is utilized to great advantage in locomotive repair shops. For instance, superheater units are repaired and later tested by means of an air cylinder on a hydraulic ram. This arrangement permits the

pressure to be gradually increased to the required point—in short, affords a method susceptible of very nice control. Again, driving-box-cellar grease cakes and pin grease for rod cups, etc., are made by means of pneumatic presses. And at McKees Rocks there is a quick-acting pneumatic press which is employed to fit in place or to withdraw daily numerous small bushings that are required extensively in spring rigging, brake rigging, and other similar parts.

For the sake of those that may be interested in further details, let it be said that, aside from general overhauling, all safety valves are examined every month; air-brake pumps are inspected at more or less frequent intervals; and the air tanks on a locomotive are tested once a year. For high-speed brakes the pressure in the train line is kept at 135 pounds. Therefore, the locomotive air tanks, from which this air flows, are subjected to a test pressure of 175 pounds and are also hammer tested to make sure that they are capable of meeting every requirement.

The piping which distributes air generally throughout the shops of the Pittsburgh & Lake Erie Railroad carries air at a continuous pressure of 100 pounds to the square inch. This air is utilized in many more ways than have been mentioned, but enough has been said to indicate how useful this motive medium is. All drinking water is raised by air lift from a well 42 feet deep, and it is with this water that the 600 employees slake their thirst.

"Under present methods of production," says Director Bain of the United States Bureau of Mines, "not more than a quarter of the oil in the ground is brought to the surface. It is often less and very rarely more." In the case of our coal-mining industry, which is always held up as an example of great wastefulness, the ratio is just the reverse. In other words, a quarter of the coal is left underground while three-quarters are brought to the surface.



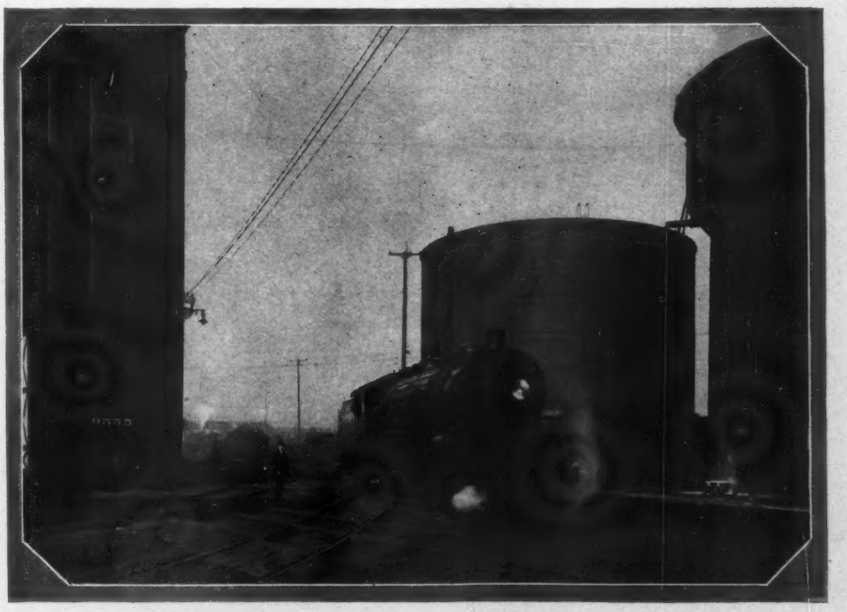
How a locomotive looks in one of the pits of the erecting shop while undergoing extensive overhauling.

HOW SALT WATER GETS INTO MIRAFLORES LAKE

THE majority of people are more or less familiar with the ordinary workings of a canal lock: they know that the operating of a lock, whether a vessel is raised or lowered, is done entirely by the flow of the water from the higher to the lower level. But that the briny water from the ocean should climb the Miraflores locks of the Panama Canal—as it certainly does to the detriment of Miraflores Lake, the waters of which are used for domestic purposes—would seem to be quite incredible. Elaborate explanations of the phenomenon have been given, but a simple one would seem to be sufficiently explanatory.

Let us assume a lock with a single lift—the Miraflores locks having two—in which a ship has been locked down from the higher level but not yet released. Under those conditions, the water in the lock being at sea level, one-half of the contents of the lock is, let us say, lake water while the other half is made up by the displacement of the vessel. The gates are now opened and the craft passes out, sea water entering to take its place. When the gates are closed, the water in the lock consists of one-half sea water and one-half lake water. So far, so good.

Lake water is now admitted from above in order to raise the water in the lock to lake level. If the quantity thus allowed to flow in is equal to that already contained therein, then there will be three-quarters lake water and one-quarter sea water in the lock. What happens when the gates are again opened and another vessel of the same displacement, for example, goes into the lock? Why, in that event, one-quarter of the lock content is driven out into the lake. When we remember that sea water is 20,000 parts salt to every 1,000,000, while a like amount of fresh water is only 5 to 10 parts salt, it is not hard to understand how it is that the water from the ocean gets into Miraflores Lake.



Leaving the repair shops: a big locomotive that has been inspected and overhauled to make it fit for another period of service.

Some of our long-established firms are beginning to show service records of employees quite comparable with those of the old world. A celebration was held recently by the Taylor-Wharton Iron & Steel Company, High Bridge, N. J., in honor of those who have been connected with the firm for years. It was noted that 281 employees have been with the company 15 years or more; 99 have worked for it a quarter of a century; 30 have spent 35 years with it; 13 have 45 years to their credit; and 11 have an unbroken record of a full half century.

Second International Petroleum Exposition

TULSA, Okla., has staged during the past month its second and highly successful petroleum show, officially described as the International Petroleum Exposition. The first exposition was held last year and was so encouragingly patronized that this year's show—covering the period between October 2 and 11, inclusive—was undertaken.

The recent effort has far exceeded the record made in 1923, and virtually every considerable engineering concern and supply company contributing to the producing and the refining of petroleum has been represented in the 1924 exposition. In fact, many of the exhibitors went to much expense to make their exhibits comprehensive, spectacular, and convincing. To this end, their machinery was of the largest sizes and set up to run so as to bring out operating virtues—care being taken to turn the spot light, so to speak, on special or particularly admirable features.

To the visitor unfamiliar with this field of industry, the show was a surprise and a liberal education, for it brought to light in how many ways the engineer, the scientist, and the inventor are joining hands to make it possible to locate oil and gas and then to recover them and to place them in one form or another at the disposal of many millions of users.

As might be expected, the compressor and the vacuum pump played conspicuous parts in the show. The vacuum pump is now extensively employed to promote the yield of slackening wells, while the compressor has far more duties to perform. For example, the compressor is utilized to effect the extraction of gasoline from natural gas and also to distribute the gas to domestic consumers, factories, etc. Again, the air compressor furnishes air for the pumping and the cleaning of oil wells; for the digging of pipe-line trenches, the assembling of pipe lines and their repair; for the cleaning of oil lines; for the construction of gas and oil tanks; for the treatment of oil during its refining; and for numerous other services essential to successful and economical operation.

Incidentally, the portable compressor is proving an invaluable aid in meeting varied demands in many fields of this great and diversified industry.

The purpose is to make the International Petroleum Exposition a permanent institution to be held every year or regularly over some other longer, fixed interval. The 1924 show was twice as large as that of last year; and the prospect is for a much bigger exposition when the third one is held.

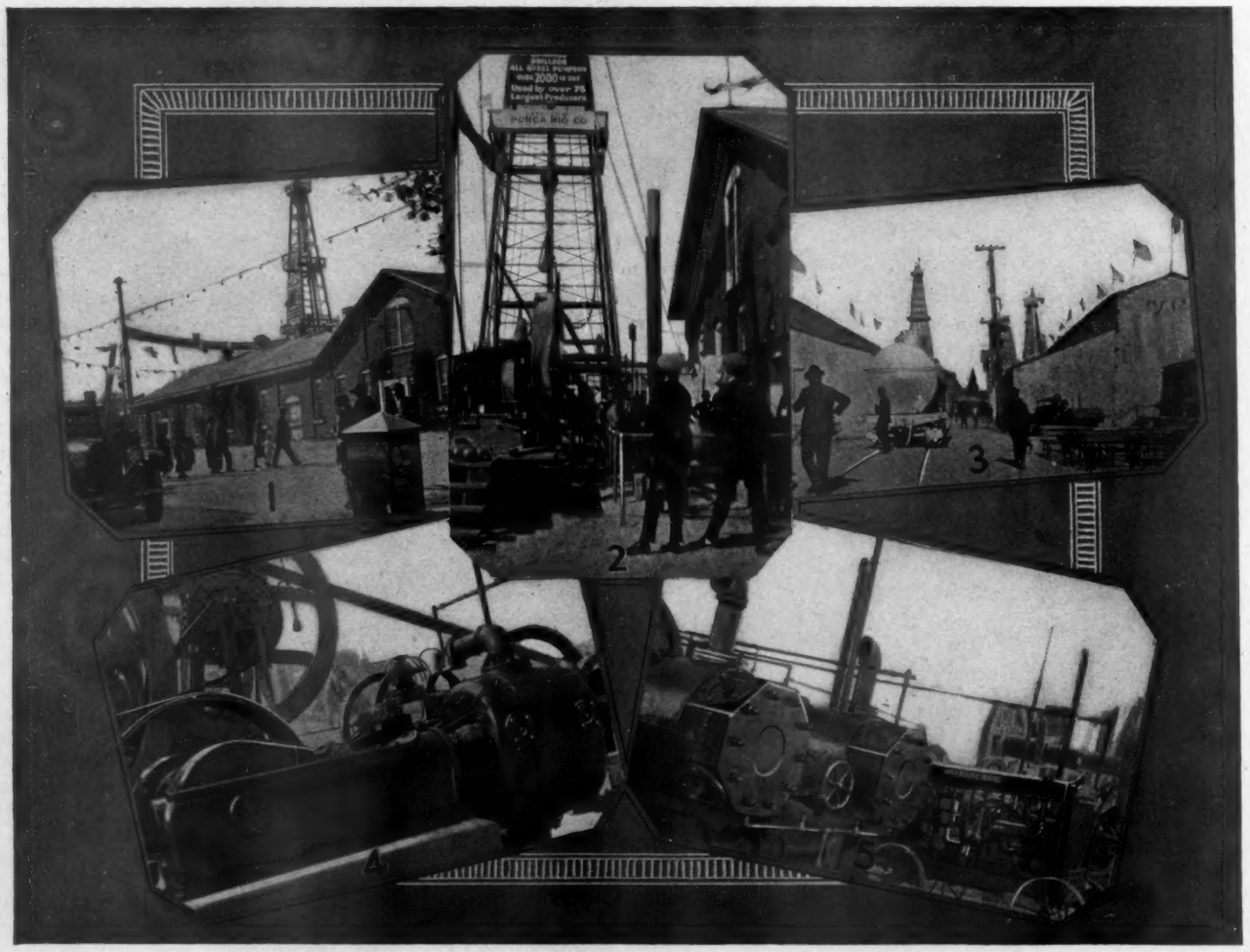


Fig. 1—One of the permanent buildings in the exposition grounds. Fig. 2—Cable drilling rig, capable of drilling to a depth of 3,000 feet, among The National Supply Company's Exhibit. Fig. 3—Some of the temporary exhibition buildings. Fig. 4—Type of vacuum pump now extensively used to promote the yield of slackening oil wells. Fig. 5—In one of the exhibition tents. To the left are compressor cylinders, on a gas-driven unit, used to compress natural gas for the extraction of gasoline. To the right, a 5x5-inch portable compressor. Machines of this description are well suited to meet some of the diversified needs of the oil industry.

Heavy ferry traffic continuously crossing the Mersey at Liverpool, England, so seriously interferes with the movements of other and more important craft that plans have been prepared for a tunnel, of generous proportions, as a means of relief. It will be 7,200 feet in length and is to have two roadways, placed above each other. The upper roadway is to accommodate four lines of vehicles and the lower one two lines of tramways. The estimated cost is $35,000,000.

Compressed Air Haulage in a Famous Copper District

Some Historical Notes About Bingham, Utah, and the Great Mineral Wealth Recovered There

By GAIL MARTIN*

COMPRESSED air has contributed generously to the prosperity of the United States Mine, which can be justly ranked as one of the world's greatest silver-lead deposits. This property, situated in the famous camp of Bingham, Utah, has been steadily productive since 1863. Within its boundaries over $80,000,000 of ore has been mined—a record surpassed by few other silver-lead bonanzas. Nevertheless, the historic property still possesses great resources which insure it many decades of prosperity.

The United States Mine is one of the most economically operated workings in Utah—a state renowned for its low-cost producers and highly-efficient mining operations. It is, therefore, interesting to know that this mine is the only one in Utah to use compressed air haulage, the cost of which, officials say, is lower than that for any other means of traction investigated. Including operation, maintenance, and renewals, the average cost per ton-mile is but 9.5 cents.

However, cheapness of service is but one advantage of compressed air haulage. Danger of electric shock or electrocution is eliminated; and ventilation is bettered considerably by the current of air kept in motion by the exhaust. For prospecting purposes, compressed air haulage cannot be surpassed because cars can be run clear to the end of a heading with no additional trouble save that of laying track.

In the mine in question, three 4- to 5-ton and two 7- to 8-ton locomotives do the hauling. The engines for the locomotives are, respectively, 4½x9x10 inches and 6x12x12 inches in size. The air receiver on the smaller type of locomotive has a diameter of 36 inches and a capacity of 50 cubic feet at 1,100 pounds pressure, while the larger one, 40 inches in diameter, is capable of holding 75 cubic feet at the same pressure. The usual pressure in the air tanks, however, ranges from 700 to 800 pounds.

The engines are of a cross-compound type—first using the air at a pressure of 250 pounds on one side and then using the exhaust at 50 pounds in a cylinder on the opposite side. The tractive effort amounts to 1,450 pounds in the case of the first-named locomotive, and 3,000 pounds in the case of the second. A drawbar pull of 20 pounds per ton gives the 4- to 5-ton type an actual net pull of 68 tons and the 7- to 8-ton type a net pull of 142 tons. The smaller engine will travel on the arc of a circle having a radius of 12 feet while the larger one can easily take a curve having a radius of 15 feet.

Charging stations, each consisting of an ordinary high-pressure globe valve with a check in the line to prevent back pressure, are placed at intervals of 3,000 feet throughout the mine. The piping is made of extra-strong ⅛-inch welded steel, and is generally 4 inches in diameter, but this is cut down to 2 inches at the inner workings.

A trip underground behind a compressed-air locomotive has a fascination. One swiftly enters the portal of the Niagara Tunnel, and darkness soon swallows up all but the space lighted by the headlight and by the carbide lamps carried by the passengers. One by one the innumerable timbers, burdened with the weight of the overlying mountain, come out of the obscurity only to go back into it again after the area of feeble light has passed by. In untimbered stretches can be seen the grim rock of this mysterious subterranean world—rock that is blemished and wrinkled like the cheeks of a patriarch old in years and in suffering.

The tail light of the locomotive glows like a ruby, and far ahead gleams a miner's lamp. One cannot but marvel at the manner in which the compressed air engine pulls long trains up a track which in places has a 2 per cent. grade as well as heavy curves. Stops to fill receiver tanks do not take on an average over 1¼ minutes. The compressors that provide the operative air for the locomotives furnish 300 cubic feet of free air per minute. The air pressure ranges from 1,150 to 1,250 pounds.

Old mines, like old ships, have a romance

*Mining Editor, Salt Lake Tribune.

Copper mine at Bingham, Utah, with its twenty working levels. The topmost of these is 1,350 feet above the lowest one. The camp's main street is seen far below in the winding valley.

Type of brick houses built by the local mining companies to give employees comfortable living quarters.

that is irresistable. So when the imagination is stirred by the sight of things that were part of a heroic or legendary past, the places become rehabilitated, repeopled again. Who, when clambering about the workings of an old mine, has not pictured the excitement of discovery, the muscle-wracking toil of development, the mental tension, the joy of long-deferred hope at last realized—or, as is so often the case, the bitterness of long waiting, the final disappointment and disillusionment.

As far as history is concerned, few mines have a more colorful background than the United States Mine, owned and operated by the United States Smelting, Refining and Mining Company. Lying within the boundaries of the property is the first claim to be located in Utah. Although a producer of millions of tons of ore "from the grass roots" down to great depths, but a small part of the estate has yet been touched. Some of its stopes have been mined as many as seven times. It is a common occurrence in the case of the United States Mine for leasers to work abandoned stopes again and again and to net remunerative returns. So often is this done that officials of the company have come to believe that there is a reconcentration of ore values due to oxidation and enrichment by downward percolating waters.

When one visits Bingham, it is hard to realize that its bare, dusty, and terraced slopes —now the scene of the huge open-pit operations of the Utah Copper Company—were once well-watered, grassy solitudes, upon the crests of which grew groves of tall, red pines. Bingham of today—with its trains of ore cars rushing across high trestles, its clangor of steam shovels, and its roar of blasting—is an industrial Babel. But there was a time when these mountains, so rich in mineral wealth, were considered valuable for grazing and timber alone.

The settlement of Utah was begun in 1847, and the pioneers believed that the pursuit of agriculture should be paramount in order that sufficient food might be forthcoming. So it followed that the vast mineral resources of Utah received but little attention until 1863.

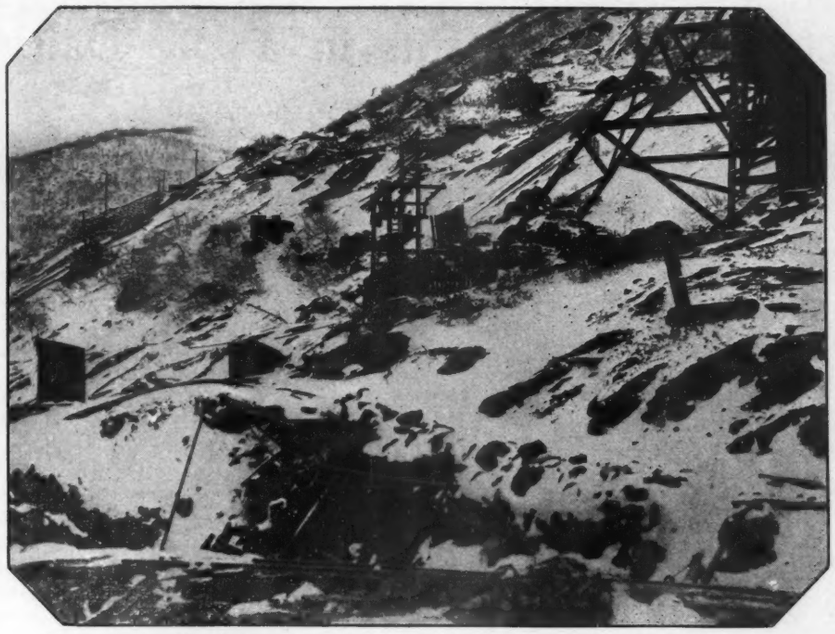
Fortunately for the state, it chanced that in the early "sixties" the Government stationed the California Third Infantry at Fort Douglas, Salt Lake City. In command of this regiment was General P. E. Connor, who had had some mining experience. He foresaw a great future for the Utah mining industry. Most of the soldiers of his regiment were hardy and experienced prospectors who had ranged the mountains of California in search of El Dorado. To encourage the hunt for mines, he freely granted furloughs: every inducement was held out to men who wanted to prospect.

In this way did the mineral development of Utah gets its start—a start that ultimately led to the discoveries of bonanzas at Alta, Park City, Tintic, American Fork, Bingham, and elsewhere. To General Connor belongs the credit for the founding of an industry that has produced over $1,418,000,000; paid nearly $260,000,000 in dividends; built practically all of Salt Lake City's finest office buildings and homes; and that has provided employment for thousands of men—an industry that, notwithstanding its tremendous outpourings of wealth during the last six decades, still faces a future that promises to surpass a past replete with splendid achievement.

On September 17, 1863, the first mining claim in Utah, the West Jordon, was staked out by George B. Oglivie, a soldier from Fort Douglas, and 24 others. In December of the same year the West Mountain District was organized. Optimistic as were the first miners—for optimism is and must be the chief stock in trade of the prospector or promoter, they could not by any stretch of the imagination have visualized the great mining enterprises that were to grow out of their modest beginnings.

Open-cut mining was not thought of in that day. The operators did not know that the mountain separating the main canyon from its spur, Carr Fork, was a mass of low-grade ore. They could not foresee that this huge deposit would be cut into a score of levels; that a railroad would be built on each terrace; and that steam and electric shovels would be used to load the drilled and blasted rock into cars to be hauled twenty miles to great milling plants near Salt Lake.

Upper camp of the United States Mine in Galena Gulch. This desolate spot was once a red-pine forest.



Here it was that George B. Oglivie first discovered ore in Utah in 1863. Out of that find has grown an industry which has produced values exceeding $1,418,000,000.

Could these pioneer soldier-prospectors be granted a furlough from the spirit world to visit the scene of their mundane activities, they would not recognize their old camp in the altered conditions of the present. They would hardly be able to grasp that the slopes opposite the Utah Copper Mine are being irrigated; that the water is caught in the Mascotte Tunnel, 1,200 feet below, where the red metal in solution is precipitated in launders; and that each month 800,000 pounds of copper is produced by "leaching-in-place" operations at an average cost of approximately 5.75 cents a pound.

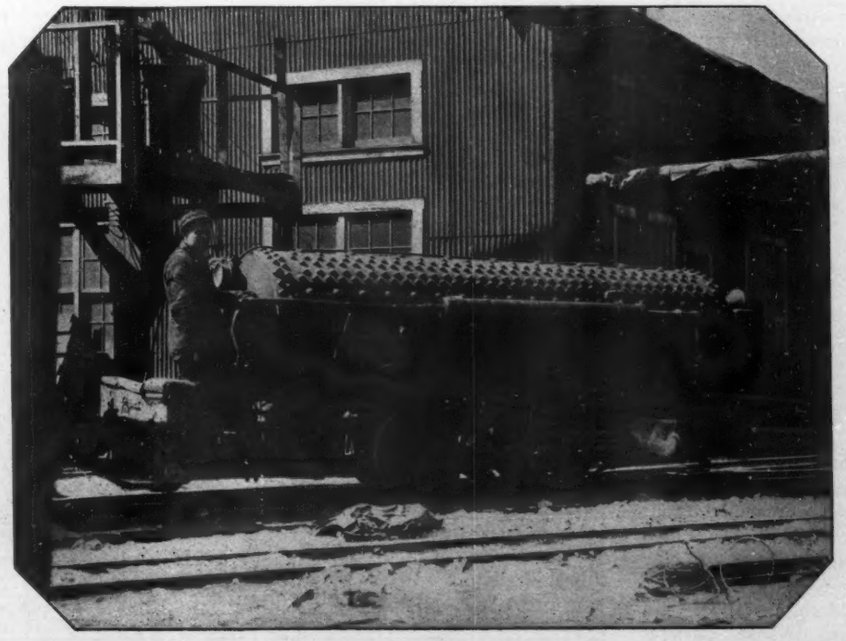
If they insisted on seeing the United States Mine, the scene of their discovery, they would still find it a property of wonderful potentialities, with over 40 miles of underground workings. They would view with astonishment the comforts provided for the employees—such as the new change room and the hotel, built by the United States Smelting, Refining and Mining Company, which afford every convenience and represent the latest thing in living accommodations. Gone is the day when the miner carried his bedding up to the mine to be assigned sleeping quarters of the most primitive kind. Now he lives at the United States Mine Hotel; he can bathe half a dozen times a day, if he so wishes; has a well-furnished room to himself; and can read, study, or play pool or cards as much as he wishes during his off hours.

Before the return to the spirit world there would be the Utah Apex and the Utah Consolidated to visit, both of which are big producers. After having made the rounds, and upon learning that the district has yielded ore exceeding $500,000,000 in value, and that the Utah Copper has the record of having paid $125,000,000 in dividends in seventeen years from ore carrying but 1.5 per cent. or 30 pounds of copper to the ton, the oldtimers would, assuredly, feel a thrill of satisfaction in the knowledge that they had discovered so great a camp and laid so splendid a foundation for future generations to build upon.

Obstacles to profitable mining were plentiful in the early days. Powder was $100 a keg, shovels cost $2.50 apiece, and other supplies were proportionately expensive. Notwithstanding the rich surface mineralization in many places in the camp, the development of lode mines ceased until 1870. In 1864, attention was diverted to placer mining by a number of Californians who, while going across country, found that there was considerable free gold. For the following six years, gold mining led in the industry; and, by 1871, the placers had produced $1,000,000 worth of the precious metal.

Completion of the Utah Central Railroad from Ogden to Salt Lake in 1869, and the construction of a branch to Bingham four years later, cut costs and brought the camp a greater measure of prosperity. For the next two decades, and until the drop in silver in 1893, silver-lead mining flourished. Some remarkable deposits were opened up. On the old Galena Claim of the United States Mining Company one can still see the pits from which rich silver-lead carbonate ores were dug. We are told that wagons were backed up to the outcrops, and that the mineral was shoveled into the waiting vehicles. Surface deposits of this type are said to have yielded ore valued at several million dollars and more.

The mining of copper on a big scale began in 1896—the first large output coming from the Highland Boy Mine now belonging to the Utah Consolidated Mining Company, which was recently taken over by the International Smelting Company. However, it was not until about 1900, when Colonel D. C. Jackling conceived the idea of treating the disseminated porphyry ores of the district on a huge scale, that Bingham entered its highest stage of activity. Development work, carried on variously by churn drilling and other means, revealed that there were in the camp huge tonnages of low-grade copper ore—in fact, the mountain separating the main canyon from Carr's Fork was found to consist for the most part of ore carrying an average of 1.5 per cent. copper. In 1907, the mill of the Utah Copper began operations; and each year since has proved that the genius of Colonel Jackling gave to the world a method of mining and milling low-grade ores that stands today as one of the most remarkable achievements in the history of mining engineering.

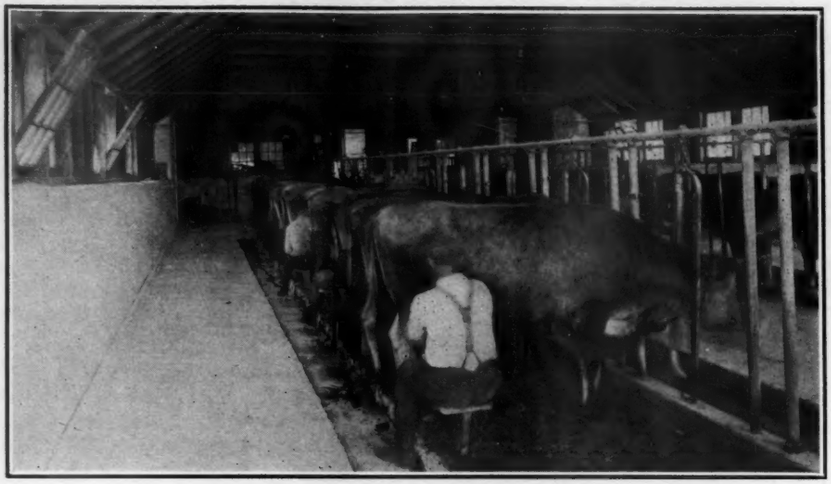


One of the compressed air locomotives used in the United States Mine. These engines have been found highly satisfactory.

Compressed Air Effects Notable Benefits in a Big Dairy

By A. S. TAYLOR

"FRESHER by a day." This is the stimulating slogan adopted by the Scott-Powell Dairies of Philadelphia, Pa., and at once the mind reacts and conjures up a picture of hastening means of transportation by which the milk of the browsing herds is brought from the far-flung farms to the central point of distribution in the City of Brotherly Love.



Milking time at one of the sources of supply.

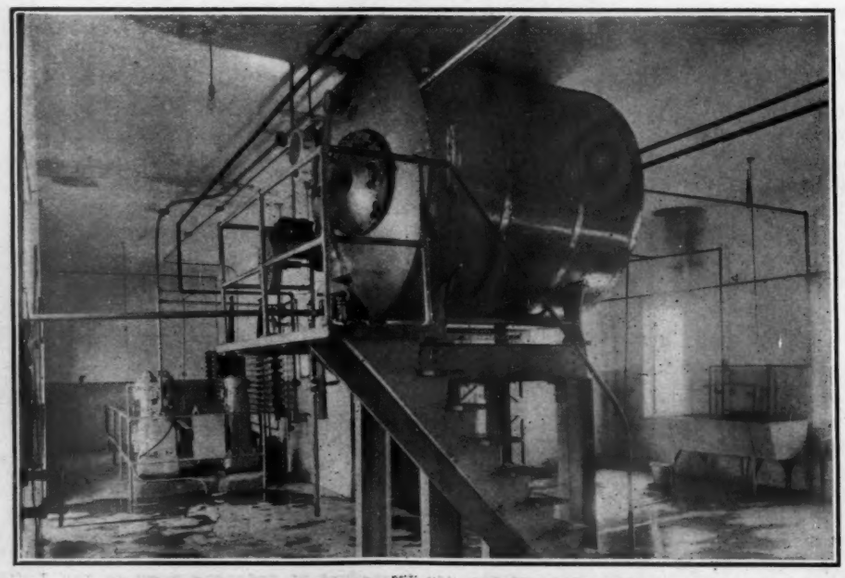
As a matter of fact, this enterprising concern has established receiving stations at strategic points along the Lincoln Highway in Lancaster County, and there are delivered every day from a total of 1,500 farms many thousands of gallons of milk. Before telling how this milk is dispatched from these stations to the main plant in Philadelphia, let us pause for a moment to consider how important a part milk plays in the national dietary.

Recent Government statistics reveal a steady climb in our per capita consumption of milk. According to the United States Department of Agriculture, each of us used in 1921 a matter of 49 gallons; in 1922, we increased this to 50 gallons; and last year our average demand amounted to 53 gallons—representing the equivalent of a daily consumption of 1.6 pints per person. In an effort to find out just how much milk means to the city dweller, the Government made a survey in substantially 300 municipalities having all told a population of 25,000,000 people, and the inquiry brought to light that the citizens of those large communities utilized *per diem* an average of 0.87 of a pint.

No inconsiderable measure of the milk used by us goes into our cups of tea and coffee; and to satisfy our palates in this way, so the statisticians inform us, the coffee drinkers require the yield of 3,000,000 cows and the tea drinkers the product of 759,000 cows which, together, constitute virtually one-eighth of our dairy herds. Besides these consumers of milk are millions of infants, children, invalids, and others whose physical well-being and the pleasurable satisfying of their appetites depend upon a plenty of thoroughly wholesome milk. So much by way of a background of a vital industry. Now let us see how the Scott-Powell Dairies meet the needs of their patrons.

At seven o'clock yesterday morning, for example, the cows were milked at distant farms. At five o'clock this morning—probably long before you were awake—the milk was left on your doorstep. This is a performance that constitutes a record in the distribution of milk in congested centers of population; and it is largely made possible by a thoroughly modern system of transportation which employs a fleet of seventeen speedy tank trucks, each of which is equipped with a glass-lined, insulated tank capable of holding 1,440 gallons of milk. Some of the trucks travel nearly 70 miles between the main plant in Philadelphia and the most remote of the receiving stations. Before the milk starts cityward it is precooled in the country; and the cork insulation of the tanks is so effective that even in warm weather the milk has a temperature of only 40° F. when it reaches the pasteurizing and bottling establishment of the Scott-Powell Dairies.

Until a short while ago, the tank trucks were emptied by means of pumps, which withdrew the milk from the arriving trucks and raised it to a height of 35 feet in order to discharge it into a big receiving tank. These pumps were steam driven, and involved fairly heavy expense in their operation and up-keep. But, in addition to this, there were other drawbacks. Pumps have a pulsating action, and they beat the milk and break up the fat globules into such minute particles that they are held generally in suspension throughout the mass of the milk. At least, that has been the experience with the company in question. Therefore, the visible cream content—that is, the "cream line," by which most housewives judge the quality of milk—is apparently reduced. As a matter of fact, the quality of the milk is not altered by its passage through the pumps; but the topping of cream is lessened, and this is objectionable if the purchaser desires to remove it for some special purpose.



Interior of one of the company's country receiving stations.

To withdraw the milk from a tank truck by pumping took 40 minutes, but even so the pumps could not completely drain the container. This entailed wastage which became serious in the aggregate. Today, an entirely different method of emptying the trucks is employed—compressed air has supplanted the steam pumps formerly in service. The system is the outcome of two years of developmental work. Air for the operation of the system is provided by a 7x5-inch "ER-1" compressor which is belt driven from an electric motor. The compressor is started and stopped automatically by a controller which maintains

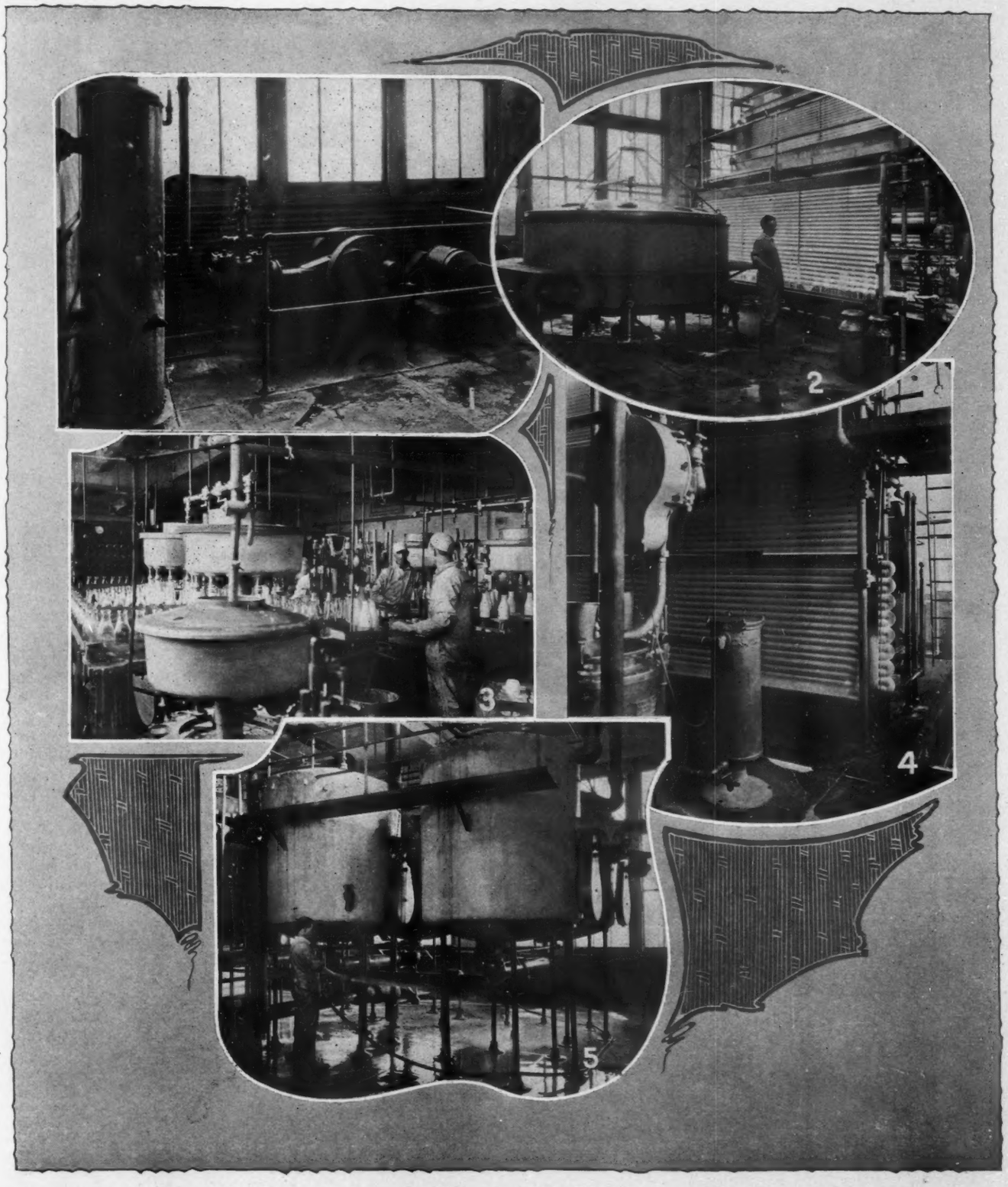


Fig. 1—This 7x5-inch compressor furnishes the air used in forcing milk from tank trucks up to storage tanks in the Philadelphia plant of the Scott-Powell Dairies.

Fig. 2—Here we have the receiving tank into which milk is delivered from the tank trucks by means of compressed air instead of pumps.

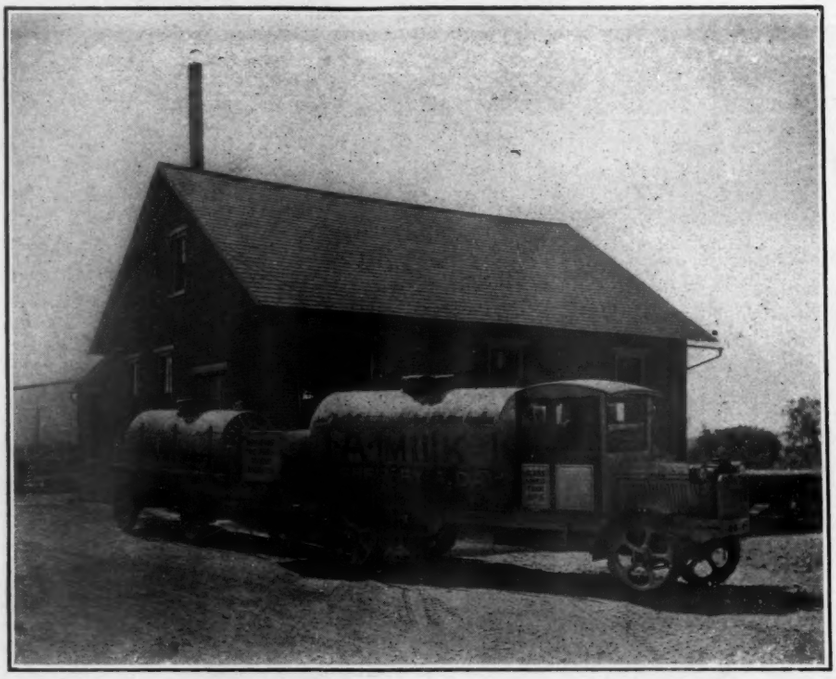
Fig. 3—Bottling department, where the containers are thoroughly cleansed and sterilized before they are moved mechanically to the filling and sealing apparatus.

Fig. 4—Some of the cooling coils which chill the treated milk after it has gone through the pasteurizers.

Fig. 5—Storage tanks which hold the pasteurized milk until it is drawn off to feed the machines in the bottling department.

the air at a prescribed pressure in a near-by receiver. The installation is shown by one of our illustrations.

Inasmuch as the equipment is designed to handle a delicate foodstuff, the air is both filtered and sterilized so as to render it absolutely pure, and in this condition it is applied at a suitable point above the free surface of the milk in a truck tank. The pressure used is 35 pounds, and this not only raises the milk the necessary height but it drains the receptacle so thoroughly that there is not enough milk left in it to wet a handkerchief. The operation requires but eleven minutes. By the original system it cost 44 cents to unload 1,000 pounds of milk; the pneumatic system, on the other hand, will handle the same quantity at an outlay of a trifle over a cent.



Tank trucks loaded with milk ready to make the run from a distant rural milk station to the main plant in Philadelphia.

As can be seen, compressed air makes it possible to unload milk faster with a minimum of waste, and, withal, much more cheaply than had previously been the case at this enterprising Philadelphia establishment. The management is so pleased with the installation and the way it works that they will gradually adopt compressed air to effect the distribution of milk for various purposes throughout their central station. Air control is also to be employed on their big holders or storage tanks from which the milk is led to the bottling machines, etc.

Limited space prevents describing the different steps by which the milk is treated in the pasteurizers, cooled after sterilizing, conveyed to storage tanks, and then withdrawn and made ready for the ultimate consumer. Each one of these operations calls for the exercise of care and the taking of numerous precautions to insure a palatable and a healthful product. We can mention, however, that the plant now produces substantially 125,000 quarts of milk every 24 hours. This output is composed of 115,000 bottles of milk and upward of 800 packages or cans of loose milk. These figures disclose to a degree what this company contributes towards the physical comfort of Philadelphia's teeming population.

A company has recently been formed which is to erect a steel plant near Burnie, Tasmania, for the manufacture of iron and steel goods for export. The crude ores are to be treated in adjacent smelters. The deposits of the Hampshire district, which are to supply the iron ore, are said to be among the richest in the world; and the large quantities of limestone in the region will furnish the necessary flux for the furnaces.

The inevitable and continuous growth of aviation activities, with flights in every direction over our broad land, demands various permanent installations, and of these none is of more importance than the means employed to indicate location, especially at night. A powerful searchlight recently installed by the Washburn Crosby Company, at Minneapolis, Minn., is thus no mere local affair but of national importance.

The light, which is 200 feet above the ground, has a 3-foot lens and is of 500,000,000 candle power. It will be visible at distances varying from 75 to 150 miles. Several similar lights have been purchased by the Government for erection in other cities.

PAINTING OMNIBUSES BY AIR BRUSH

ALL the buses of the California Transit Company are painted by means of the air brush in a specially equipped, dustproof room. At one end of the room is a 36-inch suction fan which so changes or renews the air in the chamber that four operators can work in it simultaneously. For the purpose of painting, the plant air pressure of 125 pounds is reduced to 50 pounds.

The painter's equipment is carried in a wheeled cabinet. Five gallons of paint are mixed at a time by placing the various ingredients in a can and by inserting a metal pipe and nozzle connected to an air hose. A portable, gravity-feed tower carries an adjustable rod to support the supply can at the desired height; and the paint is delivered to the spray gun by gravity. This system enables a painter to work continuously, and has increased his capacity 25 per cent.

Left—Receiving and shipping department of the plant. Right—Office end of the company's Philadelphia plant.

Essential Part Played by Compressed Air in the Field of Contracting and Quarrying in Canada

By G. R. SOUTHEE

THE USE of compressed air in the Canadian fields of contracting and quarrying has increased largely in the past decade. In fact, its application has exceeded expectations and is, in a measure, due to great hydro-electric undertakings, to the opening up of vast areas in the development of the pulp and paper industry, and to the construction of permanent highways and colonization roads.

For example, in the case of the Chippawa water-power project at Niagara Falls, lately completed by the Hydro-Electric Power Commission of Ontario, there were needed approximately 20,000 cubic feet of free air per minute. Upwards of 5,000 men were employed on the job; and the hundreds of air-driven rock drills and other pneumatic equipment utilized in pushing the work through to a successful conclusion serve to illustrate how indispensable machinery of this description is today as compared with the fairly recent past when comparatively few air-operated tools would have been seen on a project of similar magnitude.

Left—The "Jackhamer" type of drill can be operated very close to rock walls and wherever the runner can gain a foothold.

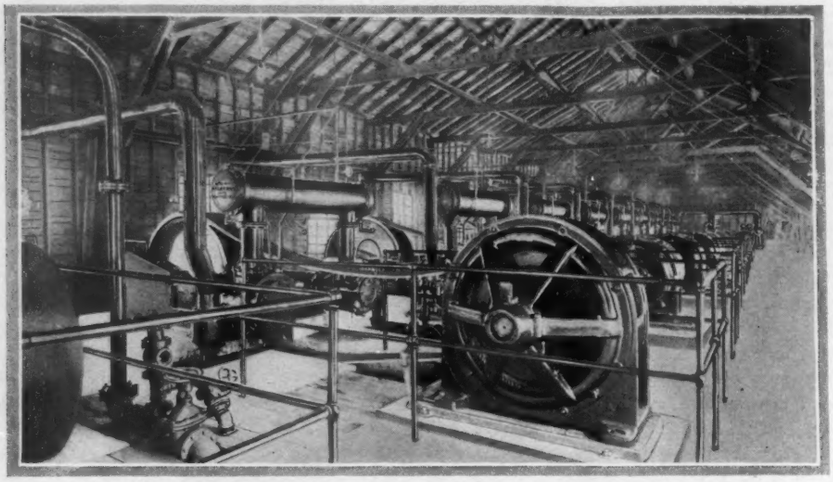
Right—Few road, street, or foundation jobs are now undertaken in metropolitan districts without the aid of paving breakers drawing operating air from portable compressors.

Bottom—"Jackhamers" on a quarry bar cutting marble. For granite and other harder rocks the heavier hammer drill is used.

Not many years ago, the average quarry secured an ample output by using a few steam-operated tripod drills. Holes were drilled on short benches, and blockholing was done by sandblasting or mud capping. These methods soon proved too antiquated because they no longer permitted economical production. In the days of cheap labor and cheap powder, large quarries could produce and market their stone at a reasonable cost, but with the general advance in the price of labor and all other commodities it was necessary to resort to other means. Working faces were increased and compressed air equipment installed. In quarries where comparatively soft laminated rock is encountered, and under which conditions the electric or gasoline-driven churn or well drill is employed to drill long, deep holes, compressed air plays its all important part in cost reduction by operating modern, heavy hammer drills for drilling toe or snake holes; by driving small self-rotating "Jackhamers" for blockholing; and by actuating drill sharpening machines, "Little Tugger" hoists, cylinder hoists, etc., etc.

In many quarries, where a short bench of 25 or 35 feet is worked, an air compressor with up-to-date drilling and sharpening equipment has increased the output per drill some 300 per cent. One of the largest Canadian trap-rock quarries has further reduced production costs by abandoning the churn type of drill and by adopting the tunnel method—using rock drills of the "Leyner-Ingersoll" type for driving deep headings, self-rotating plugger drills for blockholing, and a drill sharpener for the making of shanks and for the forming of properly gaged drill bits. The operators of brick-shale quarries have also profited by the application of compressed air. For instance, a small, self-rotated "Jackhamer," operated by one man, will in a day of full drilling give as much hole footage as could be obtained in almost one week by two men employing the old steam-driven tripod drill.

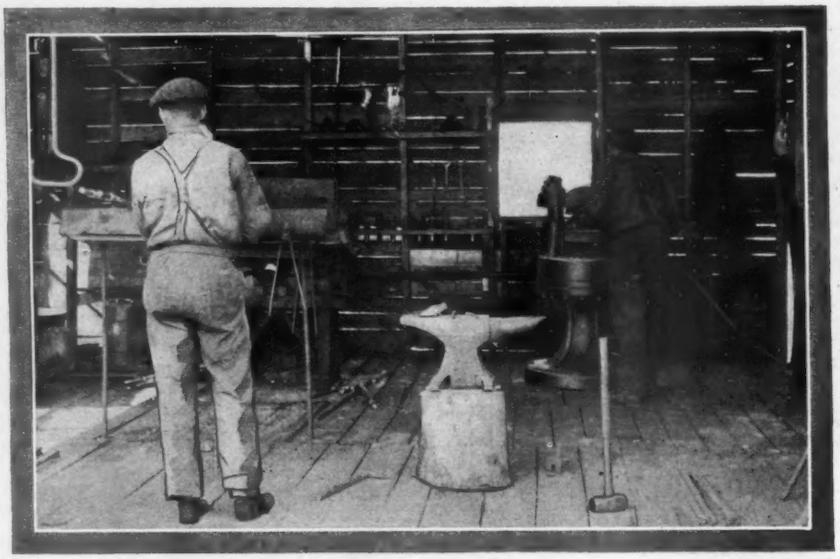
The advent of the portable compressed air power plant, that is, the gasoline or electrically driven unit, has enabled the operator of a small quarry to derive all the benefits heretofore enjoyed only by the owner of a stationary compressor. The former is now in a position to effectively use air drills, sharpening equipment, etc., and his power plant has, besides, the added advantage of portability. Modern quarrying methods point to the ever-increasing need of high-speed drills of the hammer type. As the efficiency of these drills largely depends upon perfectly formed bits and



One of the great compressor houses on the Chippewa power-canal job. This battery of machines, which supplied more than 11,000 cubic feet of air per minute, strikingly illustrates how big a part compressed air plays in undertakings of this kind. Only one man was employed in each shift to look after these units.

shanks, the air-operated steel sharpener now plays a very important part in all quarrying operations.

The most notable advance in the use of compressed air has been in the field of contracting. It is not many years ago since steam-driven compressors were employed in isolated cases and then only by really progressive contractors, whereas today well-nigh every town and city has portables operating on its streets. Their range of usefulness is wide and runs all the way from large hydro-electric developments to small sewer jobs. Large contracts, involving the expenditure of millions of dollars, demand the same efficient service from air equipment as does a modern industrial plant. As an example of what is required, a big contract which has recently been started calls for the services of two 2,000-cubic-foot compressors, each direct connected to a synchronous motor. These machines supply the air needed to operate the numerous rock drills, steel sharpeners, pumps, tools, and other pneumatic apparatus that are at work on the undertaking. It is not so long ago since steam drills, or drills operated by compressed air generated by steam produced by wood-fired boilers, would have been employed on a task of this kind. Thus, while the contractor has for years recognized the value of compressed air in his particular branch of engineering, his work henceforth—and we are speaking now of the big construction jobs—will necessitate the use of so much air that for the sake of economy he will be compelled to demand air equipment of the most efficient type.



The air-operated drill-steel sharpener is a well-nigh indispensable feature of the modern rock-drill blacksmith shop.

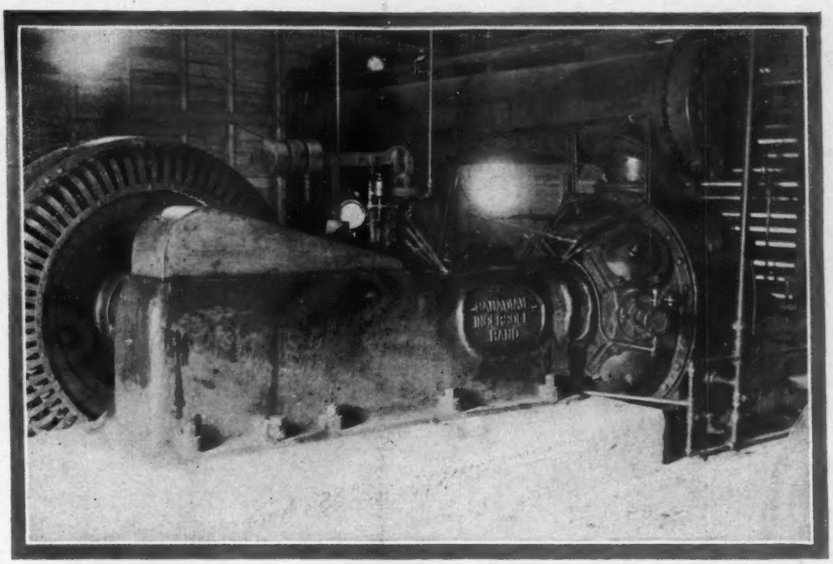
However, the small contract offers a new field for the portable gasoline-driven air compressor, because this machine has made it possible to operate many labor-saving devices that previously could not be employed owing to the cost of setting up, tearing down, and moving a stationary plant from place to place. At the present time, no matter how out of the way the contract may be, these portable units are capable of providing compressed air at any desired point.

One of the most notable examples of the use of compressed air in speeding up small-sized jobs is in the case of sewer work, which is now being revolutionized by the pneumatic clay digger. In many cities, storm sewers are being constructed by tunneling, ofttimes through clay, underneath the city streets. Recent performances have demonstrated that these clay diggers have increased production per man from 90 to 150 per cent. over that possible with the old-fashioned hand pick. The same thing is true of open-cut excavations. This fairly new implement, when fitted with an extension handle and used by an experienced operator, will loosen enough dirt to keep five or six laborers busy shoveling. Should hard rock be encountered, the contractor has enough compressed air available to drive the ever-ready "Jackhamer." Again, the pneumatic concrete breaker is proving indispensable to municipalities, contractors, and public-utility corporations. Repairs to concrete or asphalt pavements, excavating of manholes, rehabilitating street-railway systems, opening up gas mains—in short, work

A line-up of giant deep-well drills. These machines, which are capable of drilling 60-foot holes having a bottom diameter of 5 inches, are generally employed on straight-wall work.

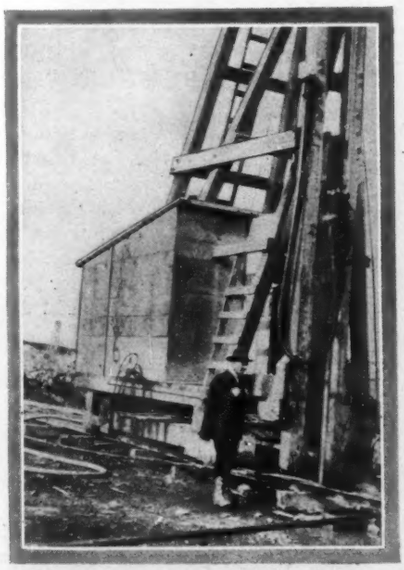
that must be done quickly to prevent needless interruption of traffic, can nowadays be accomplished in one-half the time required before the introduction of the pneumatic paving breaker.

The repair of bridges, the erection and maintenance of steel work, transmission towers, etc., all come within the scope of the contractor's work provided his equipment includes portable compressors and the necessary apparatus—such as riveting hammers, sand-blasts, wire brushes, paint sprays, etc.—for cutting out and replacing old rivets, cleaning scale, painting, and sand-blasting. Day by day the ingenious contractor is putting compressed air to many unique applications. In harbor improvement work, for example, "Jackhamers" in the hands of divers drill rock underwater for one purpose or another, compressed air operates dredge gates, etc., etc. As a matter of fact, whether the undertaking be large or small, whether it be within easy reach or fairly inaccessible, compressed air equipment is now looked upon as an essential part of every up-to-date contractor's plant.



One of two direct-connected, electric-driven compressors which together furnish 4,000 cubic feet of air per minute to drive the pneumatic equipment on a big water-power project in Quebec. There is a growing tendency to use machines of this type on large construction jobs.

In line with the plans of the United States Lighthouse Service, the air whistle on Hedge Fence Light Vessel, stationed at Nantucket Sound, Mass., has been substituted by a first-class air siren. Likewise, an up-to-date diaphone, operated by compressed air, now serves at Calumet Pierhead, Ill., in place of the old bell that was operated by machinery.



Close-up of a deep-hole drill at work on the Chippewa hydro-electric development. Many drills of this type are now being used in digging the new Welland Canal.

CANDLE POWER STANDARDS

WHILE the unit of candle power originally established in the United States was intended to be the same as the British candle, it was derived indirectly, and was later found to be slightly different from the unit in actual use in Great Britain. Through comparisons, an agreement was reached in 1909 by which the same unit was adopted in Great Britain, France, and the United States. This unit has since been accepted in several other countries, and has been definitely recognized as the "international candle" by the International Commission on Illumination. At the time, the carbon-filament lamp was the only one in service, and the standards by means of which the unit was established and maintained were of this variety.

As tungsten-filament lamps came into wider use it became necessary to establish standards of this type, and comparisons were made in 1913 and 1914 with the National Physical Laboratory of Great Britain. As the outbreak of the war interfered with the completion of this work, the United States Bureau of Standards fixed its own standards of the tungsten vacuum lamp and, later, of the gas-filled tungsten type with the expectation of making any slight adjustments in value as soon as international comparisons could again be effected.

During the past summer some lamps of both types were taken to several European laboratories for preliminary measurements. The results indicate not only that the carbon standards maintained are satisfactory but that the tungsten vacuum standards independently established in France, England, and the United States are in surprisingly close agreement. Foreign laboratories have not found lamps of the gas-filled type suitable for standards of this type, and for that reason arrangements have been made for more precise comparisons.

In the steel industry, one or two men with mechanical unloaders can now do the work of anywhere from twelve to twenty men unloading by hand.

Louisiana is to have a substantial boost in the shape of a new university, which is to be up to the highest scholastic standards. The preliminary layout is for the accommodation of 3,000 students, and the undertaking will cost $7,000,000. Even though less than half of this amount has been spent the university is to be opened this year. When finished, the school will not have cost the taxpayers one cent directly: the expenditure is being met by a tax of 2 per cent. on oil, on gas, on sulphur, and on the other natural resources taken from the state's soil.

EIGHTEEN MILES OF BELTING FOR A LUMBER MILL

IT IS QUITE fitting that the largest leather-belting tannery in the world, Graton & Knight of Worcester, Mass., should supply the belting for the world's biggest lumber mill, the Long-Bell Lumber Mill but recently completed at Longview, Wash. Reduced to a unit of 1-inch, single-ply material, the plant required 94,436 feet or nearly 18 miles of belting. Try to visualize a herd of 795 steers, and you can get an idea of what was needed in the way of hides to fill this order.

According to manufacturers, lumber mills are extremely hard on belting: only the highest grade of leather can stand up under the wear and tear of the large, heavy-duty machines. For that reason, the hides for the belting equipment of the mill in question had to come from strong, healthy steers killed during the summer months when the hides are in best condition.

An exceptionally large steer's hide. Almost 800 such skins went into the leather belting required for the world's largest lumber mill.

Gas Producer Power Plant in the Philippines

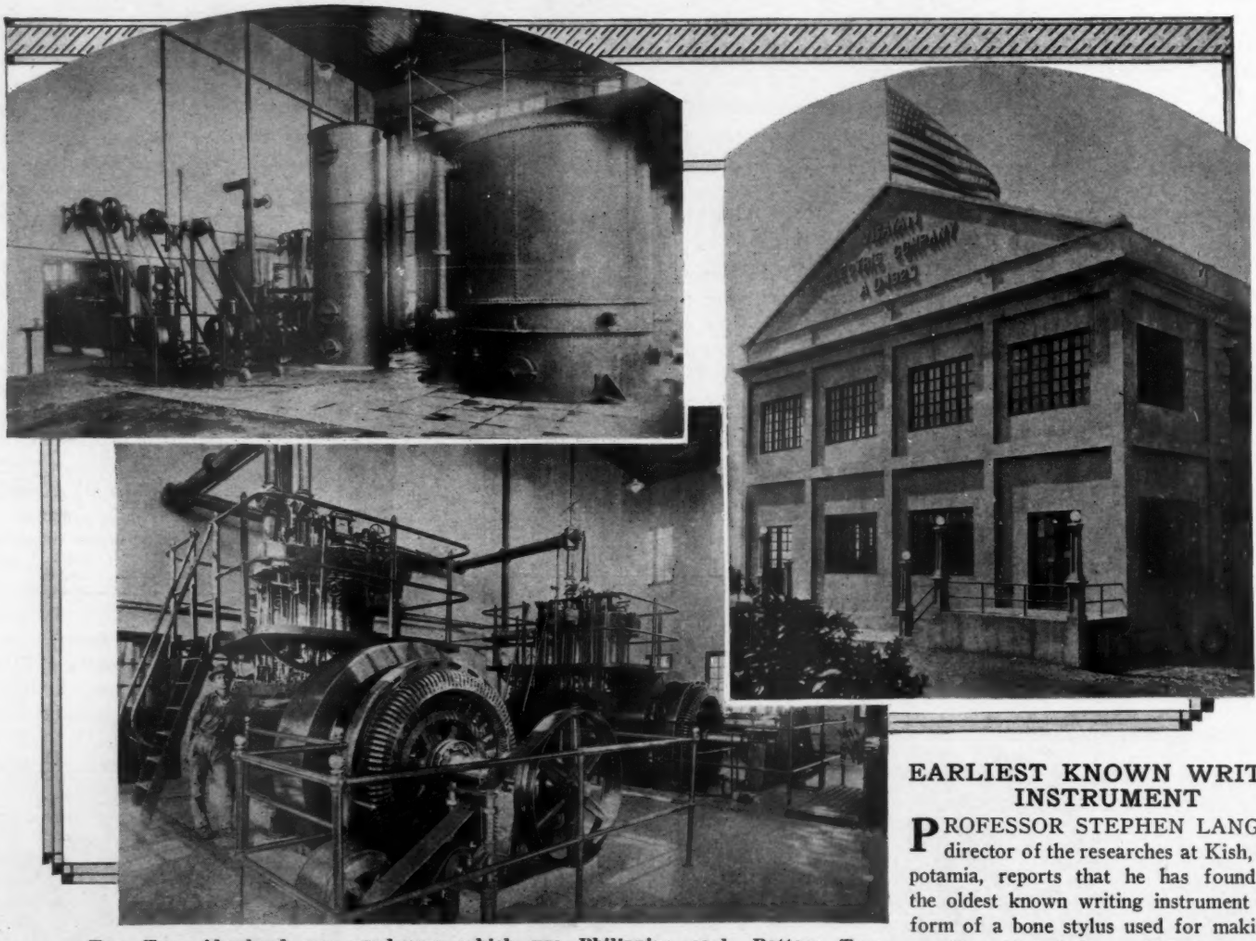
A LITTLE over a year ago a 500-H.P. gas producer plant started active operations at Cebu in the Philippine Islands, and the performance of this installation has been so satisfactory in the meanwhile that we feel justified in referring to it. The plant in question is the property of the Visayan Electric Company; and the initial problem involved was to obtain prime movers which could be operated most economically with the fuel obtainable from local sources—in other words, equipment that could utilize to advantage Philippine coal. In passing, let it be pointed out that the native coal is not of a high grade.

On the face of it, it was plain that the coal would not prove efficient if burned under a boiler; but its chemical composition gave ample warrant for the belief that it could give satisfactory and far better results if used in conjunction with gas producers for the driving of gas engines. Having settled this point, the engineers were then called upon to choose producers and gas engines which would get the most out of the available fuel. After a survey of the market, they decided to purchase two No. 30, Type "B," Akerlund gas producers and two 250-H.P. Rathbun gas engines—each of the latter to be direct connected to a 175-kilowatt generator. The electric current generated is for town lighting and for service in various small industries.

Akerlund gas producers are designed to work upon the down-draft principle and, therefore, function differently from up-draft gas producers which employ mechanical scrubbers to clean the gas before it is delivered to the gas engines. The type "B" gas producer is the outcome of wide experience, relatively simple in its get-up, and is capable of generating from low-grade coals a maximum of clean gas of uniform quality such as is required for the best work in a gas engine. The Rathbun gas engine is, likewise, the outcome of much experience and engineering skill; and the combination adopted for the Cebu central station has rendered excellent service.

The plant began to deliver current to the company's lines in September of 1923, and has been running well ever since. Philippine coal, mined from near by, has been found to be the cheapest domestic fuel and considerably more desirable as a gas producer than either Japanese or Australian coals—both of which have been tested.

What has been done by the engineers of the Visayan Electric Company is striking evidence of how modern power plants can be adapted to utilize effectively and efficiently local fuels which, at first blush, are far from promising sources of motive energy.



Top—Two Akerlund gas producers which use Philippine coal. Bottom—Two Rathbun producer-gas engines, direct connected to electric generators. Right—Front of the up-to-date building of the Visayan Electric Company, Cebu, P. I.

EARLIEST KNOWN WRITING INSTRUMENT

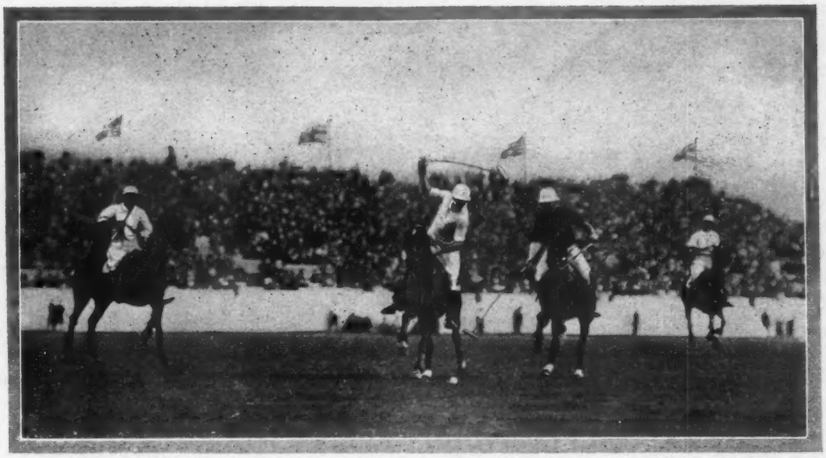
PROFESSOR STEPHEN LANGDON, director of the researches at Kish, Mesopotamia, reports that he has found there the oldest known writing instrument in the form of a bone stylus used for making the cuneiform inscriptions. This is not a pen for ink, although ink dates far back, but was utilized at a still earlier date for scratching or scoring lines in plastic material such as clay or wax.

The article found is extremely simple. It is about six inches long, triangular in cross section, and has a tapered end. With the other end rounded or flattened, if the line made was not satisfactory the wax surface could be rubbed down smooth again for another try—thus anticipating the rubber eraser on the end of the lead pencil. After a little practice, Prof. Langdon was able to make cuneiform inscriptions on clay with fair rapidity.

How Meadow Brook Polo Grounds are Kept in Prime Condition

By VERNON H. VANDIVER

TO MOST Americans, polo—the modernized game of ancient kings—and Meadow Brook, Long Island's world-famous polo club, have become so intimately associated as to be synonymous. As the mention of polo in England suggests Hurlingham so does it bring Meadow Brook to mind to all sport-loving Americans. Those who have witnessed a game from the great light-blue stands that are on three sides of Meadow Brook's No. 1 Field and have roamed about the meadowlands, to which the club is indebted for its name, need not be told of the excitement that prevails and of the beauty of the setting. But for those others who have not been privileged to sit in the stands and who are not familiar with the surroundings, a brief account of the scene of the recent International Polo Matches will not be out of place here.



A striking action picture snapped at a critical moment in the first of the recent International Polo Matches.

Traveling by train, Meadow Brook is only an hour's ride from New York City. Soon after the Pennsylvania tube under the East River is left behind, the train takes its way through Long Island's lovely country-sides. Here business men have built their homes, and here is where they come to rest and refresh themselves for the battles of tomorrow. Arriving at Garden City, a ten minutes' trolley ride takes one past Mitchell Flying Field on the way to the great polo grounds.

Alighting at Meadow Brook, the first thing that one sees is the group of grandstands, located some 250 yards away. These stands—which were erected by James Foster of Philadelphia, builder of the largest grandstands in the world—seat 50,000 people. We are referring now to Meadow Brook No. 1 Field—the field upon which the recent International Matches and the Open Championship Matches were played.

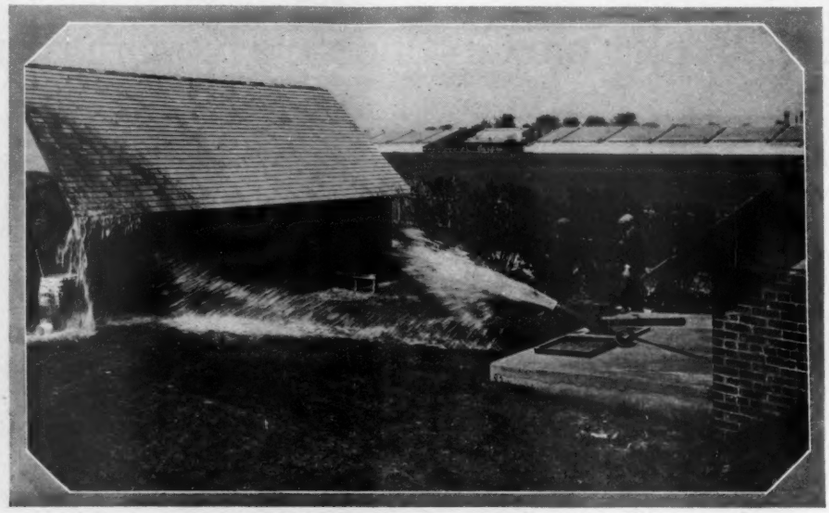
The Meadow Brook Club has five polo fields, each of which is used on an average three times a week. It also has an 18-hole golf course. Each of the polo fields save one, No. 5 Field, is 450 feet wide and 900 feet long. No. 5, or Cochran Field, is 450 feet wide and 1,300 feet long. The combined area of these five fields amounts to more than 55 acres.

The maintenance of 55 acres of turf and of an 18-hole course may seem like a big task to most of us, especially when we consider the rough usage to which the polo grounds are subjected. George Richardson, the greenskeeper at Meadow Brook, says it is not so much a question of difficulty as one of a plenty of water as well as continual care, even while the game is in progress. Perhaps Captain H. C. C. Tippett, General Manager of the Club, gave us a cue when he remarked: "Mr. Richardson knows something about grass."

Now let us see just what it means to keep a polo field in good condition. Assuming that a game is about to be played, 35 or 40 men armed with wooden tampers are stationed around the grounds. Eight players, four to a team, mounted on fresh ponies take up their positions in the center of the field. Then the umpire, also mounted, throws a willow-wood ball 3¼

Meadow Brook Clubhouse and Its Surroundings Are Distinctly Reminiscent of Colonial Days.

inches in diameter between the opposing ranks, and the game is on. For a period of 7½ minutes plus, the 9 ponies, going at top speed, are digging up the turf and sending it flying. When the time is up, a bell rings; the ball is played out of bounds; and, while the players are gone after fresh mounts, the army of tampers swarms over the field to smooth the turf—packing and replacing the hundreds of clumps of grass just the size of a hoof, standing on edge. So the game continues for eight periods, or *chukkers,* each of 7½ minutes plus duration. When the contest is ended the tampers are lined up shoulder to shoulder so as to thoroughly cover the field and not to leave even a bit of the sod upturned. The matter of tamping, Mr. Richardson explained, is an important one, for grass roots exposed to the air die.



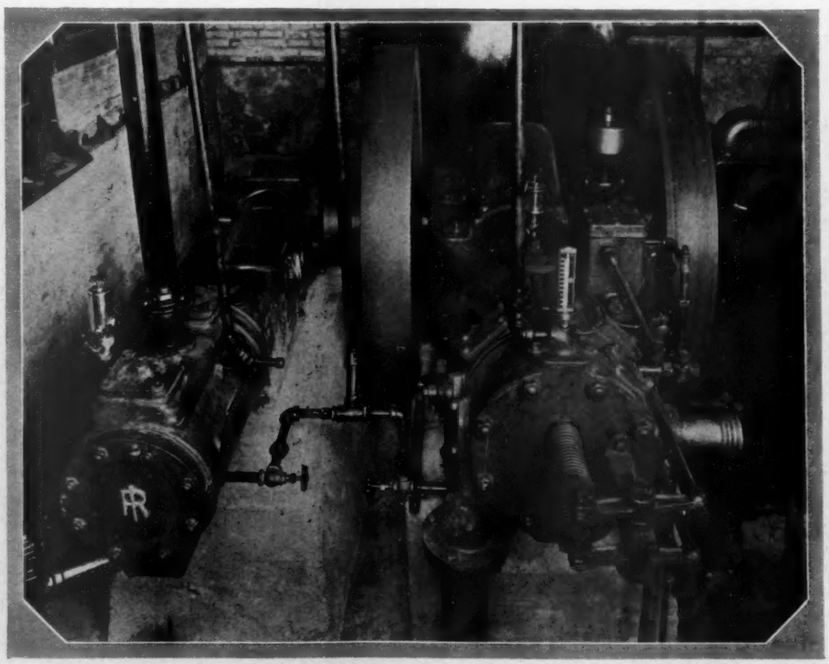
The air-lift pumping plant, at the right, showing with what force the water is discharged from the sump tank.

We might liken the replacement and tamping of the turf to first-aid, as there are yet bigger jobs to be done. Every other day the grass is cut close, and big, heavy rollers are pulled over it many times by Fordson tractors until the hoof prints are almost obliterated. In the spring and summer months each field is watered three nights a week for three hours continuously with six 2-inch fire hose.

The enormous quantity of water required for this purpose as well as for the golf greens is supplied by the club's own pumping plant, which embodies some of the very latest improvements in pumping equipment. The water used comes from deep wells, and is raised by an air-lift pump which discharges into a sump tank. Thence distribution is effected by a 3-inch Cameron centrifugal pump and a pressure tank.

Air for lifting the water is furnished by a 9x8-inch Ingersoll-Rand "ER-1" compressor driven by a 50-H.P. Ingersoll-Rand Type "PO" oil engine to which it is directly connected through a floating-ring coupling. This engine operates on the 4-cycle principle, injects its fuel right from the service tanks, and starts without preheating or electrical ignition. Ignition is obtained by heat of compression only. The entire layout—engine, compressor, and pump—is the product of one manufacturer. The very best service is obtained by so centralizing the responsibility for satisfactory performance of equipment.

Now to return to the subject of taking care of the turf. By the end of the season—the latter part of October—there are hundreds of hoof prints so deeply impressed in the sod that no amount of rolling or tamping will smooth them out. It is most important that these be removed, for otherwise the field would soon be disqualified for the game. This is done, Mr. Richardson explains, by "spudding." A sharp implement, similar to a spade, is utilized to pry up the ground, which is then tamped and rolled preparatory to spreading over the polo fields their winter blankets of well-rotted manure.



The compressor, which supplies the needful air for pumping the water, and its prime mover, the 50-H.P. oil engine. Just back of this installation are the centrifugal pump and the pressure tank, by means of which the water in the sump is distributed.

In conclusion, just a word about Meadow Brook's 18-hole golf course. This was designed by Captain Tippett and laid out in 1922 by Mr. Richardson. Though it has not yet reached maturity — it usually takes four years to whip a course into shape—we are informed by no less an authority than Mr. Grantland Rice, the well-known sport writer, that it will be the best course in the United States. Perhaps it might not be out of place here, for the benefit of the suburbanite, to give the following simple rules that Mr. Richardson observes in keeping his greens healthy and velvety: "Cut close to kill weeds; use sulphate of ammonia to discourage clover; sweep cut grass to prevent brown patches; roll to make the grass spread; and water each night for from two to three hours."

AIR-DRIVEN HOIST ON A CONSTRUCTION CAR

FROM the *Electric Railway Journal* we learn of something new in derrick cars, which is provided with an air hoist such as is used for handling materials in repair shops.

The hoist is suspended from a horizontal beam placed about seven feet above the floor and lengthwise between the motorman's cabs of an ordinary flat car. A chain from the end of the hoist runs over a series of pulleys to a rotating derrick arm; and, when compressed air is applied through the operation of a valve, the hoist lifts loads attached to the end of the derrick boom. Obviously, the hoist draws its motive power from the air system of the train.

Through standardization, "one large railroad system," so we are told by Ray M. Hudson, Chief of the Division of Simplified Practice, "has reduced its stocks of supplies from 140,000 to 78,000 items." By applying the same principle, the purchasing agents of some 40 large roads have "cut down inventories 37½ per cent. and released $180,000,000 of hitherto 'frozen' investments."

Extending Electrical Conduits Under Difficult Conditions

By C. M. HARTLEY*

THE CONSTRUCTION of underground conduits for electrical conductors is a branch of engineering and contracting about which little has been written for the technical press. It is, perhaps, on the whole, a subject of more concern to electrical than to civil engineers. At the same time, there are certain phases of this work when prosecuted on a large scale under adverse conditions, such, for example, as are generally found in New York City, that involve interesting structural problems.

In 1923, the 36th Street tunnel was the outstanding feature of a season of great activity in underground construction in Manhattan. The character of this work reflects the trend of the times as regards the laying of conduits or, for that matter, of any other subsurface lines beneath the streets of the City of New York. It is becoming increasingly difficult to find unoccupied spaces in what might be termed the upper stratum, and it is therefore necessary, in many instances, to build considerably below the street surface.

The depth at which new trunk lines must be located is influenced by two factors: first, the size of the proposed structure, and, second, the underground conditions along the projected route. In 1917, we placed 43 ducts in 36th Street across Seventh Avenue, leading them to the original West 36th Street telephone central office. Six years later 140 ducts were to be carried across this intersection, but upon investigation it was found impossible to take them over the roof of the existing rapid transit tunnel: we were therefore forced to go under it.

*Engineer, Empire City Subway Company, Ltd.

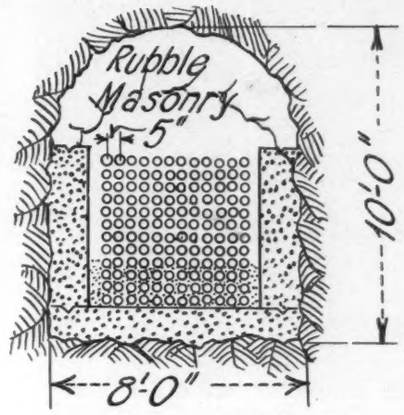


Fig. 1—Typical cross section of the tunnel with conduits in place.

The space occupied by the 36th Street conduit line, of which the tunnel section is only a part, was required when it was decided to enlarge the telephone central building. Upon completion of the 12-story addition now under construction, this edifice will have a total capacity of two manual and five machine-switching units, and a semi-mechanical toll-board. The present installation comprises the Longacre manual and the Pennsylvania machine-switching switchboard. The central office is on the south side of 36th Street between 7th and 8th Avenues, while the subway, extending from 6th to 8th Avenues, is located on the north side—the center line of the tunnel being five feet south of the north curb line.

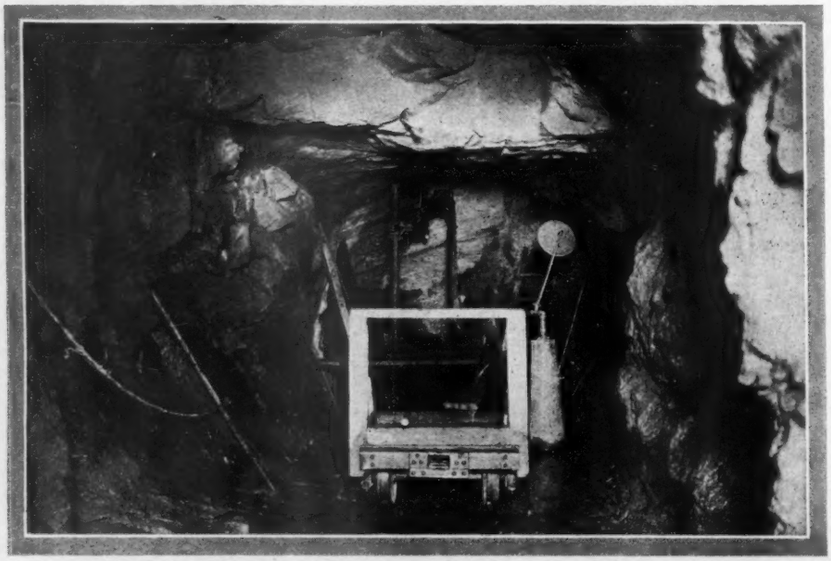
The job of carrying the conduit beneath the subway presented many varied and interesting angles, which might be dwelt on at length if space permitted; and, as finally executed, is a fine example of underground iron pipework accomplished under troublesome surface and subsurface conditions. Iron piping was used for bends and curves that could not be made of vitrified-clay units. An existing manhole on the east side of 6th Avenue was torn out and enlarged, necessitating the removal of the brick foundation or footing of an adjacent Sixth Avenue elevated column, the bottom of which was but five feet below street level. This footing was replaced by a concrete pier carried down 12½ feet to solid rock—the elevated structure being shored up in the meanwhile on steel girders spanning the excavation. The new manhole is 24 feet deep from the street surface to the finished floor.

As may be seen from Fig. 2, the 3½-inch

Left—Drill runner at work in a manhole. The excavation of the two shafts was a more difficult task than the driving of the tunnel.

Right—Drifters of the type illustrated help to speed up the laying of electrical conduits. In congested districts of large cities, work of this kind that is apt to interfere with traffic must be done as quickly as possible.

Picture taken from center of tunnel while the 3½-inch iron pipes were being put in place.



Near one of the headings. Here we see the type of car employed to carry mucking buckets to and from the shafts.

Looking east on 36th Street, showing where both shafts were sunk east and west of Seventh Avenue.

iron pipes, 140 in number, are brought into two manholes, one on either side of 7th Avenue. Before work on the conduit could be started, it was needful to sink two shafts: one at a point 14 feet west of the west curb of 7th Avenue and the other 24 feet east of the east curb line. The excavation for the east shaft was 36 feet deep and 13 feet in diameter and was started on June 18, while the west shaft, commenced shortly afterwards, was 31 feet deep and 13½ feet in diameter. As rock was encountered in both shafts at 11 and 16 feet, respectively, it was found expedient to remove it by the aid of pneumatic rock drills. These were operated by air at a pressure of 90 pounds provided by two electrically driven compressors —one for each shaft.

Drilling and blasting was done by two gangs, each consisting of a blaster and four drill runners. Two 1-ton, stiff-legged derricks, one with a 12-foot and the other with a 15-foot boom, handled the muck from the shafts and also from the tunnel. These derricks were actuated by 4-H. P., gasoline, single-drum hoists; and the special round iron buckets used in conjunction with them had a capacity of ⅕ of a cubic yard. Safety catches on the buckets and safety hooks on the leads were utilized to such good effect that no accidents occurred during hoisting. This equipment was, what might be termed, a hoisting plant in miniature, as the size of the job did not warrant the erection of hoppers. However, these 1-ton units have been found very efficient for deep excavations in streets where there is no room to spare either below or above the surface.

On account of the congested traffic in 36th Street, no accumulation of excavated rock on the street could be permitted. The derricks were, therefore, placed on heavy timber platforms over the shaft openings and the rock dumped in waiting wagons as fast as it was hauled surfaceward.

In general, the excavation of the two shafts was more difficult than the driving of the tunnel. The north face of the west shaft was carried down alongside the brick vault wall of the 12-story York Hotel, and in the case of the east shaft the vault wall of the Mills Hotel, a 15-story structure, was exposed. Therefore, the timbering of these excavations above rock level had to be of such a nature as to shore up these brick walls, to support the exposed mains, and to brace the sides of the shafts. The exposed rock foundation beneath these vault walls being somewhat soft and shattered, it was necessary to apply a concrete facing over a considerable area—binding it to the rock by means of steel pins. The south face of the excavation laid bare a large brick sewer which had to be underpinned and cradled for some distance in a concrete envelope.

Approximately 850 cubic yards of rock were drilled and blasted out of the shafts—the rock for the most part consisting of Manhattan schist varying in hardness and interspersed with mud seams. Fortunately, it became firmer as the excavation deepened. At the bottom, 50 feet below the street surface, it was found to be fairly solid.

The tunnel section is 110 feet long and 8

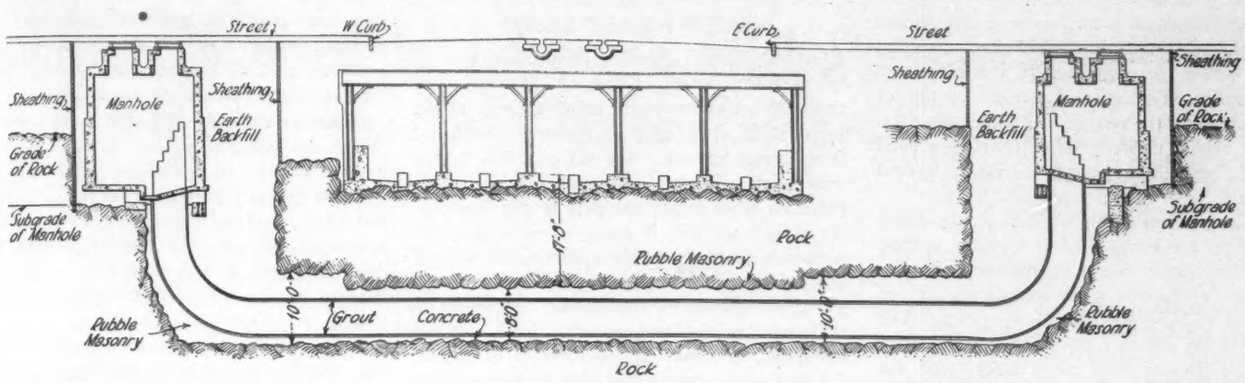


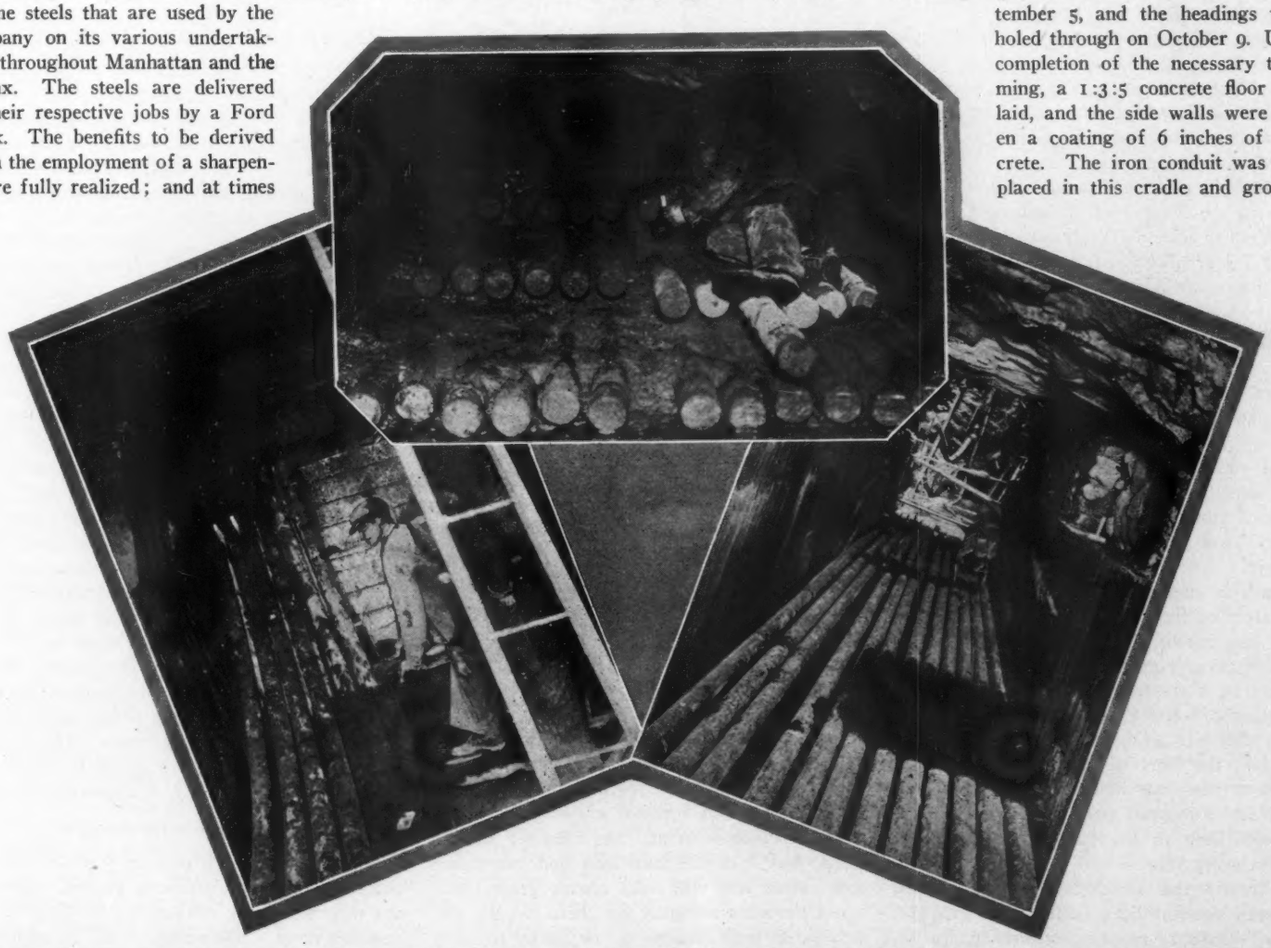
Fig. 2—Cross section of 36th Street illustrating relation of rapid-transit subway to the tunnel built for electrical conduits.

feet wide throughout. The portals have a height of 10 feet, which is reduced to 8 feet under the rapid transit structure. The driving of the tunnel was accomplished easily and without any untoward incident—drilling, blasting, and mucking proceeding in rotation and from both ends simultaneously. One man only was employed to do the blasting—alternately going from one heading to the other. The air-driven drills, using 1⅛-inch, hollow, round steels with 6-point bits, operated efficiently—cutting the rock at an average rate of 11 inches per minute. The steels were kept fit for their service by means of a drill sharpener which is in a store yard in the Bronx and takes care of all the steels that are used by the company on its various undertakings throughout Manhattan and the Bronx. The steels are delivered to their respective jobs by a Ford truck. The benefits to be derived from the employment of a sharpener are fully realized; and at times but one blacksmith has handled all the steels needed for 22 "guns"—that is, sharpening on an average 265 bits per day while a second blacksmith heat treated them.

The holes drilled had a maximum depth of 5 feet with a starting diameter of 1¾ inches. As there was but 14 feet of rock between the subgrade of the subway tracks and the tunnel roof, no chances were taken in blasting. In other words, speed was sacrificed to safety at all times by resorting to high drilling footage per cubic yard of rock removed and light blasting charges. This condition obtains in a large percentage of the rock trench work in New York. An average progress of 5 feet of completed excavation was made in the two drifts per day.

After the headings had been driven a distance of 15 feet from the portals, two small flat cars, running on a 24-inch-gage track, were used to convey the muck-laden buckets back to the shafts, whence they were hoisted to the surface. A total of 300 cubic yards of rock was thus taken out of the tunnel. Very little water was encountered; and two 2- H. P. diaphragm pumps—one for each shaft—kept the workings dry. One pump was set on a bench halfway down the shaft while the other was on the street.

Drilling operations were started on September 5, and the headings were holed through on October 9. Upon completion of the necessary trimming, a 1:3:5 concrete floor was laid, and the side walls were given a coating of 6 inches of concrete. The iron conduit was then placed in this cradle and grouted.



Left—Long-radius pipe bends which connect the ducts in the tunnel with those in one of the shafts. Top—How the tunnel looked when sealed near the west shaft. Upper rows of ducts visible. Right—Some of the iron-pipe ducts in position on the floor of the concrete-lined tunnel. Bottom of one of the shafts seen in the distance.

The duct formation is 12 feet wide and 12 feet high, and the numerous pipes are spaced 5 inches center to center both vertically and horizontally. The space between the top of the conduit and the roof of the tunnel was filled in with rubble masonry—thus forming a solid structure beneath the subway to insure against settlement.

The long-radius bends of iron piping which connect the horizontal conduit with the vertical risers were made in the aforementioned store yard: there was not room enough on the job to attend to that part of the operation. The vertical ducts entering the floors of the manholes are divided into two banks; and the tiers of pipes are staggered to make for greater ease in handling the cable plant. After the pipe installation had been completed, the shafts were backfilled up to the elevation of the bottom of the manhole floors; but, despite the care taken in doing this, some settlement will undoubtedly occur. To guard against this in connection with the manholes, they are carried on a series of 15- and 20-inch I-beam supports set into the rock sides of the shafts. All the grout and the concrete used was handled by a 10-cubic-foot mixer and delivered into the forms from the street by means of a chute.

The whole undertaking, including the manholes and the tunnel run beneath the subway, is a fair example of the kind of work and the type of equipment that is now often required in laying conduits for electrical conductors. This job, which was done under the direction of Mr. Henry S. Swain, chief engineer, was planned and executed by the Engineering and Construction Department of the Empire City Subway Company, Ltd., of which Mr. Clement I. Walker is general superintendent. The conduits built by the company are occupied by the cables of the New York Telephone Company, the Western Union Telegraph Company, the Postal Telegraph Company, and other interests using low-tension circuits.

DEAD SEA A POSSIBLE AID TO PRODUCTIVITY

THE biting salinity of the waters of the Dead Sea has made that body for thousands of years incapable of supporting either animal or vegetable life. Now comes the news that those very waters are to be the means of stimulating the fruitfulness of farm lands. This paradox is readily explainable, however.

Potash is an indispensable plant food; and the waters of the Dead Sea carry in solution, so it has recently been discovered, a considerable percentage of this alkali. This potash can be extracted by a simple process at an outlay of only $5 a ton. Further, so it seems, this fertilizing substance can be delivered at the Port of Haifa at a total cost of $15 a ton—just half the price now obtained for European potash, of which great quantities have in the past been shipped to America every year.

Apparently the Dead Sea, which has so long been deemed little better than a blight, is now, thanks to modern engineering, to become a great asset to Palestine and a boon to other parts of the world.

SAND-BLAST SAND

SAND-BLAST sand is a product that is now very much in demand. Formerly its application was confined almost entirely to the foundry to clean and to remove inequalities from rough castings, but today it has a far wider field of usefulness even though it still plays its most important part in the foundry. Nowadays, we find it doing effective work in removing paint from old surfaces, in carving and in engraving stone and marble, in cutting glass, in cleaning or renovating the walls of stone and brick buildings that have become discolored, in preparing the surfaces of metals for the electrolytic bath, and in putting the final finish on metal surfaces.

The main producing centers of this particular kind of sand, according to W. M. Weigel of the United States Bureau of Mines, are New Jersey, Ohio, and Illinois. New Jersey produces both bank or lake and beach sand, while the Ohio and Illinois sands are obtained generally from more or less coherent sandstone. Those from Ohio usually require crushing. The Illinois deposits are less consolidated, and even though they require blasting to loosen up the beds they disintegrate and fall to pieces in water sufficiently to enable the material to be handled by dredging pumps.

Mining is carried on by steam shovel if the bank is above water level and will not hold water for a dredging pond. But if a pond can be made, mining is usually done by hydraulic dredging—the centrifugal pumps being placed on a floating dredge. The material so obtained is delivered to the washing and screening plant through long pipe lines. In some localities, as along ocean beaches, recovery is accomplished by locomotive cranes equipped with clamshell buckets. In all cases, the sand must be washed. Where the raw product is particularly clean this may amount to only screen washing. Other methods, however, include the use of sand cones and helical screw washers.

Next comes drying. The usual practice is to dry the entire product after washing. For this purpose, both stationary steam dryers and revolving mechanical dryers are employed. The larger sizes, Nos. 3 and 4, are commonly handled by revolving screens of woven-wire cloth, while the finer sizes are separated on shaking or vibrating screens. Sometimes the sand is screened twice to assure a uniform product. The grades generally turned out are Nos. 1, 2, 3, and 4—No. 1 being the finest and No. 4 the coarsest. Some producers make a No. 0; but there is little call for this variety. Aside from the size of the sand, the characteristic shape of the grains is of importance.

Considerable difference of opinion exists as to the relative merits of sharp, angular, and rounded grains. Advocates of sharp-grained sand claim faster cutting, whereas those in favor of sand of rounded grain insist that it does smoother work and has a longer life—in short, that it can be used over and over again and makes less dust. All quartz grains have about the same hardness, but there is a big difference in their "toughness" or ability to resist crushing and shattering. No method of determining this property other than actual use has been developed. The results of plant tests would be interesting; but, on account of the many variables entering into the work, would be misleading unless carried out most carefully.

In nearly all cases the sand is re-used until the grains become too fine to accomplish the desired result. In reclaiming sand-blast sand, the dust that is separated from the coarser material has, heretofore, generally been considered worthless, but now we learn that this waste dust can be put to service in the foundry. According to The United States Silica Company, it may be utilized as follows:

As a foundry parting, it is shaken from a bag exactly as ordinary parting is applied; mixed with dead core or gangway sand it forms excellent cores, especially for thin, difficult work; it can be used as a core wash in place of ordinary silica dust; under certain conditions, it can be employed as a foundry facing, but the foundryman must exercise judgment in applying it to various classes of work; it can be mixed with clay for luting the covers of annealing pots; and it has been utilized successfully as an interlining between the brick flooring and the metal bottom of annealing and other furnaces. A layer of dry dust, 1½ inches thick, imparts a cushioning effect to the brick floor that aids in preventing breakage under heavy loads. The sand also insulates the bottom of the furnace, and thus lengthens its life.

FROM STEAM TO OIL-ENGINE ELECTRIC DRIVE

THE Atlantic Refining Company of Philadelphia, Pa., is adding to its fleet of oil-engine, electric-driven vessels by converting the tanker *Anahuac* into a craft of this type. Contract for the work has been awarded to the Bethlehem Shipbuilding Corporation.

The *Anahuac* has an overall length of 180 feet, a width of 31 feet, a molded depth of 17 feet, and a capacity of approximately 10,000 barrels. Her new propelling machinery will consist of two 225-H.P., Ingersoll-Rand, direct-injection oil engines, direct-connected to 155-kilowatt, 125-volt, direct-current generators. Both the generators and the single 250-volt, direct-current propelling motor—which is rated at 375-H.P. at 120 revolutions per minute—will be furnished by the General Electric Company. The equipment is similar to that installed in the *Van Dyke* tugs I, II, and III, which were recently placed in service by the same company and described in detail in the Magazine.

This makes the fifth vessel for which oil-engine, electric drive has been adopted by the Atlantic Refining Company. The fourth one is the tanker *Allentown*, to be renamed *J. W. Van Dyke*, which was but lately purchased from the United States Fleet Corporation. This ship is to be provided with three 840-H.P., direct-injection oil engines of the aforementioned type.

A refrigerator ship recently left the port of Seattle carrying equipment to build a cold-storage plant at Bethel, Alaska, for the freezing of reindeer meat. The vessel, itself, is scheduled to bring the frozen meats down to Seattle for distribution.

Problems Involved In Laying a High-Pressure Gas Main Through the Busy Streets of a Large City

By E. H. PAULL

THE LAYING of a 24-inch gas main is, in itself, a man-sized job; but, aside from the usual obstacles encountered, added difficulties present themselves when the work must be carried through the heart of a large city such, for example, as the national capital. In laying five miles of high-pressure mains through the streets of Washington, D. C., the Washington Gas Light Company has many problems to contend with.

Facing the foregoing limitations, the company started work on the project on March 14. So as not to interfere with traffic, it is necessary to undercut or tunnel beneath railroad and street-car tracks, crossroads, and all runways leading to adjacent properties; and the sand and excavated material have to be so piled that they will not cover the sidewalk or sections of the street. The trees along the way also had to be taken into consideration, der which the Washington Gas Light Company has to operate—conditions that hamper progress all along the line—the management was not slow to appreciate the advantage offered by compressed air and pneumatic equipment. The successful strides being made on the job today are rightly attributed to compressed air, which is doing the bulk of the work.

Everything possible is being done to speed up operations. Among other things, two

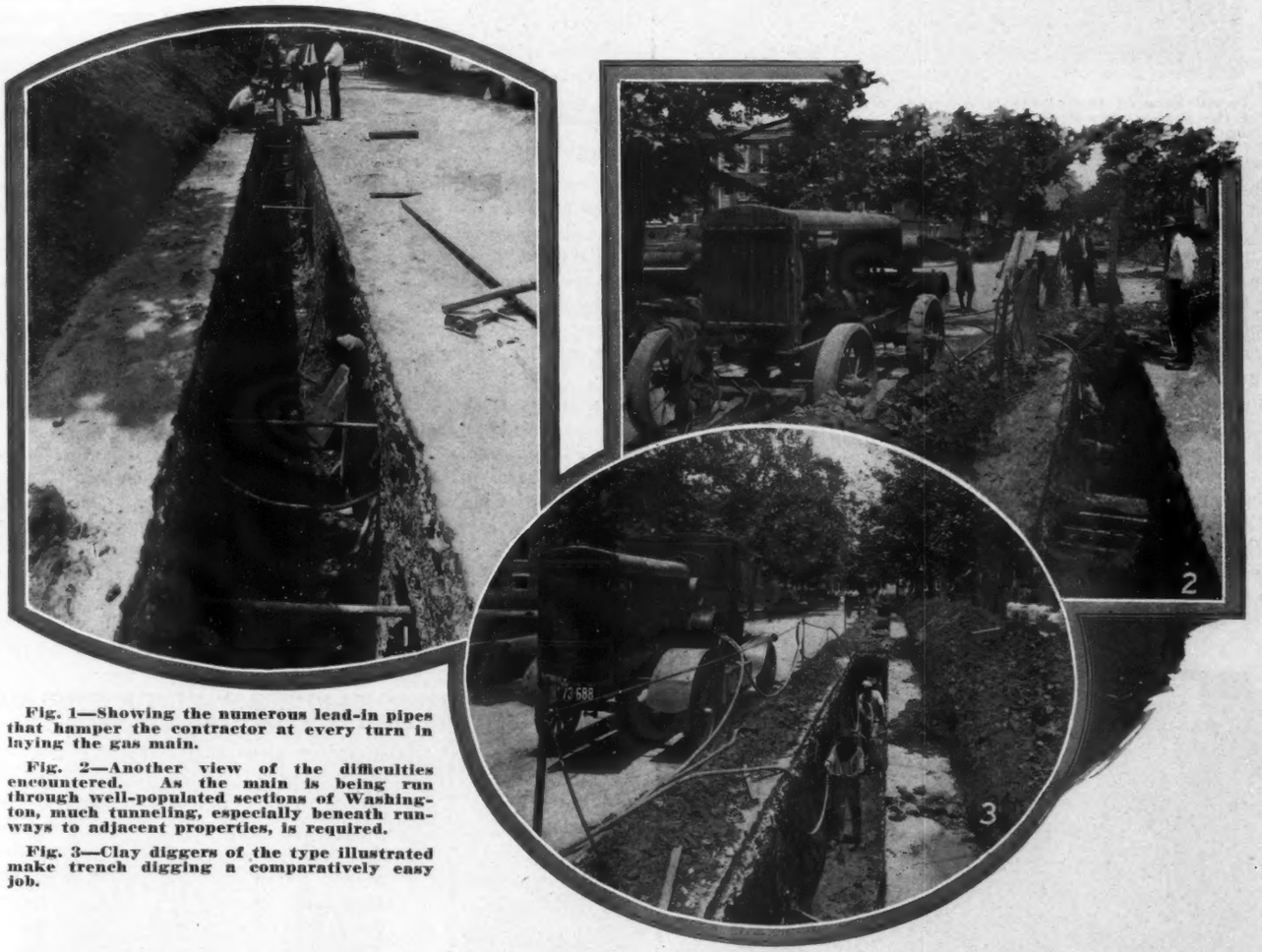


Fig. 1—Showing the numerous lead-in pipes that hamper the contractor at every turn in laying the gas main.

Fig. 2—Another view of the difficulties encountered. As the main is being run through well-populated sections of Washington, much tunneling, especially beneath runways to adjacent properties, is required.

Fig. 3—Clay diggers of the type illustrated make trench digging a comparatively easy job.

Progress at the start was very slow, for restrictions were many, and ways and means had to be devised to overcome these handicaps. Among other requirements, the work was in no way to tie up traffic of any description; it was not to interfere with the water and the sewerage systems of adjoining properties; and, when completed, that portion of the street overlying the gas main was to be level with the rest of the street—that is, any subsequent sinking of the ground in question would have to be remedied by the contractor.

with the result that each one is securely wrapped to protect it against the sand and gravel as well as the tools with which the work is being carried on.

The numerous lead-in pipes to the houses present a most difficult problem to the excavators. Some of these water, gas, and sewer pipes are a foot under the street surface, while others are anywhere from two to three and even four feet deep. This variation in depth demands extreme care in digging if trouble is to be avoided. In view of the conditions un-

of the portable compressors on the job have special hose reels. These reels, which are on the roofs of the compressors, have proved to be great time and labor savers when moving from one place to another. With this new arrangement, it is possible to send air through the line without unreeling all the hose: only as much of it as is required for the work in hand need be unwound. It is an ideal provision for a short-time job or where the compressors must be shifted around to different points on the same project—there is little de-

In advance of the pipe-laying gang: removing the concrete sub-base by paving breakers after the asphalt has been taken up in the form of slabs. Note the demountable air-line reel on top of the portable compressor.

lay in starting a portable at a new base of operations on account of picking up, loading, and unloading the air line. Owing to the size of the undertaking, four Ingersoll-Rand portable compressors supply air to the various paving breakers, clay diggers, sand rammers, and grinders employed. These Type Twenty machines—two of which are 5x5-inch, one 6x6-inch, and the other 7x6-inch—are all direct connected and driven by gasoline engines.

The new pipe line starts at the company's east station at 12th and M Streets, S. E. From there it runs west to 10th Street, north through 10th to Florida Avenue and L Street, N. E., west on L to 1st Street, north on 1st to O Street, west on O Street to New Jersey Avenue, N. W., north on New Jersey Avenue to S Street, and thence west on S to 11th Street and Vermont Avenue. The new gas line will dump into the various trunk lines now operating along this route. We might add here that the company has also made preparations at the power end of the line so as to be able to meet increased service demands. To this end they have recently installed a 15&32x 20" XPV-1 gas compressor for the purpose of compressing the gas to be distributed through the new pipe line.

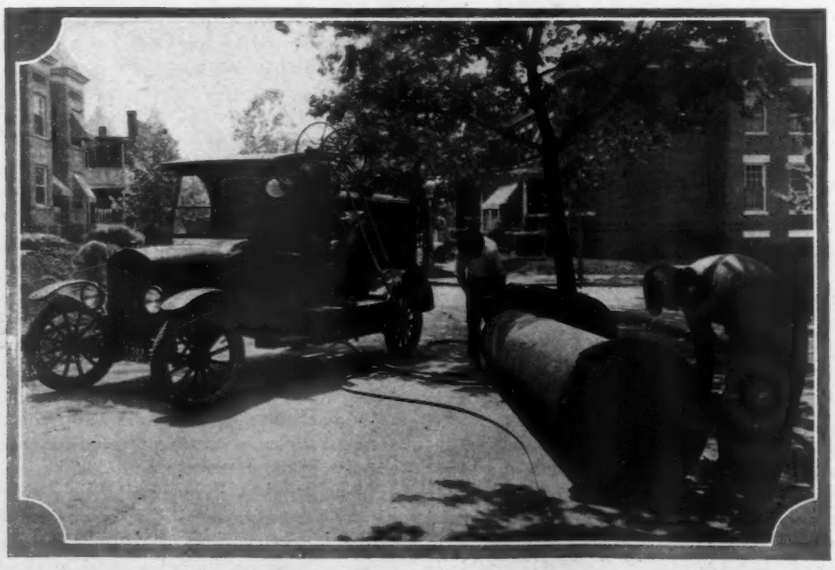
The work is carried on systematically, and enough ditch is opened up so as to keep about two blocks ahead of the pipe-laying gang. The asphalt is cut into blocks and removed with the aid of concrete breakers fitted with wide-end chisel bits. This part of the program, which would be a slow and tedious job if done by picks or pickaxes, is now a rapid, easy operation. Two chalk lines on the asphalt show just what part of the street is to be taken up; and then two men, armed with concrete breakers, cut through the asphalt right along the lines while a third similarly cuts the long slabs into blocks, which are carried away. To dispose of the concrete base underlying the asphalt, regular moil-point steels are employed. In cutting and removing asphalt and concrete, one man with a paving breaker can accomplish as much work as a gang of fifteen men using hand methods.

After the hard surface has been lifted, all further excavating is done by air-operated clay diggers. The soil is a very compact clay-and-sand mixture which is readily handled by the spades. All dirt is removed from the ditch by hand shoveling. The ditch is from 8 to 12 feet deep and 34 inches wide.

The lowering of the new main is a more than ordinary job, inasmuch as it is a ticklish problem to get the units between and under the numerous service lead-in pipes without damaging the latter. Once in place, the pipe sections are blocked and the joints made tight by cementing. This process has been found to be superior to lead calking. As clean, bright surfaces assure better contact with the concrete, it is necessary before making the joints to remove all rust, scale, or other foreign matter from the ends of the pipe sections. This work is done quickly by the aid of pneumatic grinders.

After several pipe units have been cemented together the ditch is filled in. A stream of water is then played on the loose dirt so as to pack it well around the gas main and to assure a solid foundation for the topping of asphalt. Everything is done to prevent subsequent settling and to avoid the expense of again tearing up the street.

At the present writing, about 3¾ miles of piping have been laid, and Mr. Duncan D. Ransdell has every reason to believe that the entire project will be completed by Christmas Day. As previously brought out, no small part of the splendid progress made despite innumerable odds is due to the resourcefulness of the contractors and to the adaptability of the compressed air equipment on the job.



To assure the making of tight joints, the ends of the pipe units are cleaned by means of pneumatic grinders.

TAPPING A RIVER THROUGH A MOUNTAIN RANGE

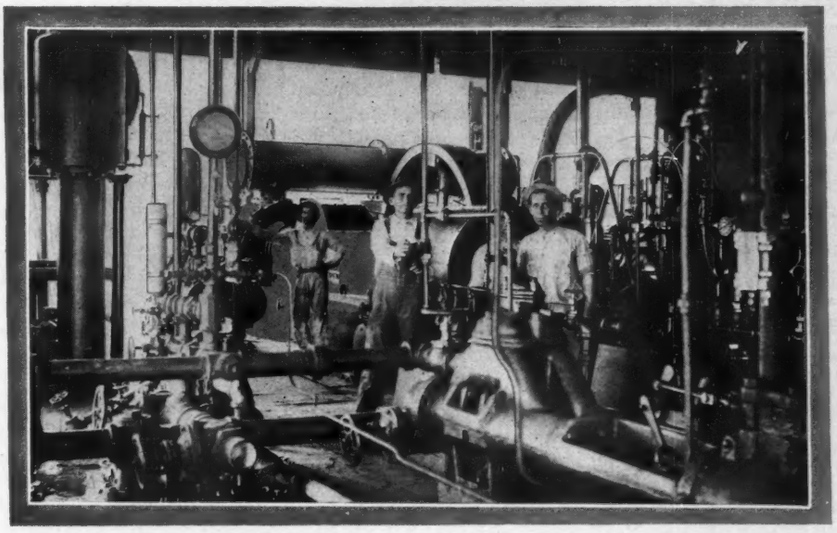
IN ITS work of transforming arid regions into fertile farmlands, the United States Reclamation Service is now pushing through another big irrigation project in the Roubadeau and upper Gering Valleys in western Nebraska. A tunnel, known as "Number Three," has already been driven; and it is through this passageway that the waters from the North Platte River, flowing by way of the Fort Laramie Canal, will be diverted at a point eight miles west of Scotts Bluff Mountain.

The tunnel is 6,500 feet long, and pierces a range of mountains. The work of excavating was begun simultaneously at both ends and, when the two headings met, there was a variation laterally of but ⅛ inch and in grade of something less than ½ inch. All that now remains to be done is the placing of about 9,200 cubic yards of reinforced concrete. This phase of the undertaking is to be finished in time to begin irrigation next spring.

Compressed Air's Novel Service in a Cuban Railway Shop

By THE STAFF

THE Province of Camaguey is the second largest district of Cuba, boasting a population of 98,193. This province, which is in the southeastern section of the island, produced in 1923 a total of 7,630,509 bags of sugar, and in this respect was the most fruitful of the Cuban provinces. Manifestly, the handling of this bulk commodity lays a heavy burden upon the existing transportation system, and it is therefore easy to understand why the Cuba Railway Company has seen fit to establish repair shops at the Town of Camaguey in the heart of this important region. We are fortunate in being able to show some recent photographs of different phases of these shops, which have an important part to perform in keeping the rolling stock of the line fit for its tasks.



In the engine-room of the railway repair shops, showing compressor installation, feed-water heater, etc.

Until sometime during 1923, all the pumping for different purposes was done by steam-driven pumps, and this steam was furnished by two locomotive type of boilers that burned fuel oil. To be specific, the steam-driven pumps distributed both oil and water throughout the shops and also pumped fuel oil to the two locomotive boilers in the old pump house. These boilers were chronically leaky, and because of that condition they were unequal to the work expected of them: there was more often than otherwise an inadequate supply of water and oil just when these were needed most. Accordingly, certain of the operating authorities cast about them for some dependable means of relief. The difficulty was disposed of by buying and installing a large 24-inch Ingersoll-Rand compressor of the XPV-3 type. This is a steam-driven machine.

Steam for general purposes in the shops is generated by a thoroughly up-to-date battery of four oil-burning boilers, and they are of ample capacity to operate the air compressor and all the other machinery about the plant. The compressor, in its turn, supplants the old and defective boilers by providing motive air for the pumps previously run by steam. Water is raised from a deep well by three duplex pumps that deliver it to a storage tank located 310 feet away and, in doing this, elevate the water a matter of 103 feet. The compressed air for driving the deep-well pumps travels a distance of 1,260 feet between the power plant and the well. The adoption of compressed air and the abandonment of the old locomotive boilers have brought about a substantial reduction in charges for fuel oil and labor and also have lowered considerably the maintenance cost for this pumping service. Full credit is due Colonel John McVey, superintendent of motive power and shops, and Mr. J. W. Griffith, superintendent of shops, for the innovation.

According to one of these officers, "Since we have been operating our pumps with compressed air we have had no further difficulties. We have been able to reduce the working force 50 per cent. in the pumping plant. We are pumping on an average 96,000 gallons per day, during a 16-hour day, with very good results."

In conclusion it might be stated that compressed air is now utilized in many other ways throughout the Camaguey shops of the Cuba Railway Company.

In order to determine the factor of safety of arch dams, plans have been formulated by the Engineering Foundation of New York City to test such structures to the breaking point. A fund of $100,000 is being raised for the purpose.

Left—One of the several oil pumps that are now operated by compressed air. Right—Close-up of oil-burning boilers in the power plant.

Compressed Air Magazine

—*Founded* 1896—

Devoted to the mechanical arts in general, especially to all useful applications of compressed air and to everything pneumatic.

Business and Editorial Offices:
Bowling Green Building, No. 11, Broadway, New York City. Tel. Bowling Green, 8430

Publication Office: Somerville, New Jersey

TERMS OF SUBSCRIPTION

$3 a year, U. S. A., American possessions and Mexico; all other countries, $3.50 a year, postage prepaid. Single copies, 35 cents. Back issues more than six months old, 75 cents each.

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EDITORIALS

PAPER MACHINE DESERVES WIDER APPRECIATION

IT IS WELL occasionally to call attention to the mechanical night-and-day toilers, upon the unfailing output of which we implicitly depend for so many of the essentials of our comfortable, everyday life. We think of food and drink as normal requirements without which we could not exist; but what of the printed page—our mental food? Could we imagine modern life without it? And who can measure our dependence upon the tireless machines that give the world an unlimited supply of materials for papers, periodicals, and books?

The evolution of the printing press and its present-day marvelous achievements have been sufficiently described from time to time; and its inevitable self-advertising service keeps it continually before the public. But how many of us give a thought to the paper-making machine whose product flows from it night and day, as water pours down a mountainside, and disappears as fast as it is made?

When the Fourdrinier "paper engine," as it was first called, began its work in England as far back as 1803, it was well at the forefront of the mechanical wonders of the day. Since then, thousands of inventors and ingenious artificers, mostly unknown to the world, have done much to improve and to perfect it, so that it is now no less wonderful than it was 121 years ago.

Individual machines are capable, for example, of turning out rolls of paper 219 inches wide at a speed of 700 to 800 feet per minute, and are designed to operate up to 1,000 feet per minute or more than 11 miles an hour. At this velocity the area of the paper produced per hour would amount to more than 25 acres, or nearly a square mile for the full day. Our amazement at man's ingenuity must grow apace when we are told that the prepared wood pulp, as it enters one end of the Fourdrinier machine, consists of about 1 per cent. fiber and other materials and 99 per cent. water, and that in traversing its length—say 200 feet—substantially all the water disappears and the dry paper emerges at the other end. It is, indeed, a great sight to see the paper flow.

With increased speed of production, such as is especially the case in the making of newsprint, the starting of a new sheet and the handling of the forming paper would invite grave accidents to the attendants were it not possible to control many of these essential operations by means of compressed air. In short, compressed air has many useful things to do at various stages in the manufacture of paper.

OUR SHRINKING WORLD

WE HAVE it on the authority of an eminent scientist that this globe of ours, large as it is measured by miles around the equator, is going to be too small to sustain us comfortably in the course of the next eleven hundred years—a mere fraction of time when we consider the probable age of the earth.

To bring the problem home to us, Dr. RAYMOND PEARL ANDREW of Johns Hopkins University predicts a population of 197,274,000 for the United States in the year 2100, while Dr. H. P. FAIRCHILD of New York University calculates that we shall have within our gates "550,000,000 at the end of the twentieth century." Happily, there is considerable diversity between the figures of these learned gentlemen; and for the nonce we need not worry about short rations, due to too few fertile acres, even though we have ample reason to find fault with the prices charged for our daily provender by the butcher, the baker, and their kind.

What is true, and cheeringly so, is that the world is shrinking in a sense so that distances—widespread desert places and watery wastes, no longer hold people apart as they once did within the memory of men still living. Where sailing ships took weary weeks to cross the ocean, fleet steamers now speed from shore to shore in as many days. Where the caravan or the "prairie schooner" required months to make its toilsome way from coast to coast of our land, the airplane spans the distance between the dawn and the dusk of a single day. Where until lately the telegraph was the quickest means by which to send a message from New York to San Francisco, vocal intercourse with all the clarity and vigor of a "local" call is now possible between these extremes. And today the human voice can be carried by radio through space and above the Atlantic from America to England with virtually the velocity of light!

Whatever may be the scientists' speculations about the population of the globe in the centuries to come, we cannot gainsay the fact that man's inventive cunning has, in effect, brought about a terrestrial contraction which makes for a broader and a better human understanding. There is room for a good deal more of this beneficial shrinkage through man's annihilation of time and space.

SAVING MORE OF OUR MONEY

LAST year, according to a report made by CHARLES H. DEPPE, of the American Bankers Association, we tucked away in the form of savings the equivalent of $166 per capita. Aside from representing a staggering total of more than $18,000,000,000, the deposits marked an increase in the nation's thrift as a whole—more than half of all bank deposits being accounts of this sort.

Mr. DEPPE said: "An examination of the growth of savings deposits shows that the total savings deposited in 1923, amounting to $18,373,062,000, almost equal the total individual deposits in all banks on June 30, 1913. The population for the same period increased 14 per cent., individual bank deposits 88 per cent., savings deposits 108 per cent., and the number of banks reported as receiving savings deposits 266 per cent."

Probably nothing is more significant in this thrift trend than the part played in it by school children. To quote again from the same source: "As of June 30 of this year, there were 683 banks reporting school savings representing 9,080 schools with 3,095,012 pupils, of which 2,236,326 participated in savings—the collections amounting to $14,991,535 and the reported bank balances totaling $20,435,-144." These figures tell a heartening story, and should serve to silence those critics that persist in calling us a nation of dollar chasers and spenders.

OUR UNRECOGNIZED ACQUISITION OF POWER

FOR THE greatest increase in available power, that is, measureable horse-power, within the present century we are indebted to neither water nor steam, to neither coal nor oil nor gas. Electricity and compressed air have had nothing to do with it.

Wealth, individual or national, dollar wealth or horse-power wealth, comes to us not through the initial possession of it but through the saving of it and the wise employment of it. Most is got out of a dollar not by locking it up but by so spending or employing it that we get a dollar's worth or more out of it. The status of horse-power wealth is precisely the same, and the means of accomplishment through horse-power wealth is identical with that of dollar wealth.

The story of power saving which is going on all over the land, with its attendant acquisi-

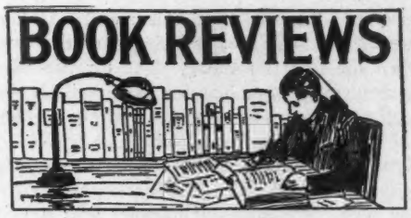
tion of wealth by reason of more available power, is a simple one. Curiously enough, it is not the saving of vast amounts of costly power which is most quickly recognized and appreciated, if recognized at all. Who, for instance, when riding his Ford over the smooth and even surface of an up-to-date highway does not think first of all of the joy of it and last of the littleness of the power actually consumed. Then, too, there enters into the matter the question of the much greater amount of power which would have been needed for a ride, devoid of pleasure, over roads such as those to which we have been so long accustomed.

It would seem to be time for all of us to begin to evaluate the actual wealth which improved highways contribute to the nation through the mere saving of power, and to understand what power costs in dollars and cents. The gain derived with the automobile that is used for pleasure has not yet been adequately computed in arithmetical terms, but in the case of horses and mules drawing loaded wagons we have some figures which are very suggestive. At the Iowa State Fair it was shown that a team with a tractive pull of 2,300 pounds was sufficient to start 24 tons of coal going over a smooth and level pavement and strong enough to pull 66 tons after the load was got underway. It was also revealed that it is easier to pull 3 tons on a concrete pavement than 1 ton on a firm dirt road—and not a bad road at that. A new farm wagon loaded with 6,240 pounds of sacked grain required a tractive pull of 32.5 pounds per ton on the pavement against 134.7 pounds on a good dirt road.

The possible savings suggested by a few simple figures would lead to staggering results if widely applied, and we will therefore not attempt to analyze them. The work of making good roads is going on at a gratifying pace all over the land; and there is no surer way to save national wealth on a big scale than by such an economy of power. One essential thing should be remembered. The very best roads are not more than half at their best until we have them everywhere, for every vehicle must always be equipped for passing the worst spots, though these may be few in number and infrequent.

SHOVEL CRAWLS 28 MILES TO ITS WORK

TO reach a road construction job in the Shenandoah Mountain section of Virginia, so we read in *Engineering News-Record*, a gasoline shovel made a trip of 28½ miles under its own power. Provided with crawler traction, the machine left a railroad siding at Staunton, Va., on May 9, and arrived at its destination at noon on the 14th—the actual traveling time being 25 hours. It must be noted that the route traversed was not along a graded and paved highway: the journey had to be made over rough mountainous country, and involved the crossing of a stream where water 4 feet deep was encountered for a distance of 600 feet.



EVERYDAY BIOLOGY, by J. Arthur Thomson, M.A., LL.D., Regius Professor of Natural History, University of Aberdeen. A book of 262 pages, published by George H. Doran Company, New York City. Price, $1.25.

WE may resent being likened to a machine, but when all is said and done no mechanical fabrication of man, in his most skilful and inventive moments, is in any wise comparable with the human organism that has made these achievements possible. As a matter of fact, the human body—using the term in its all-embracing sense—is virtually an aggregation of associated engines which are wonderfully interrelated and interdependent in their functions. The patient, painstaking men of science have, step by step, unraveled and made plain some of these vital marvels; and the sum of this knowledge is covered by that field of learning known as biology.

Professor Thomson has undertaken to tell in an unconventional manner some of the outstanding aspects of biology, and he has written in a way that makes his handling of the topic both absorbing and informative. The book is designed for the non-technical reader; and most of us could peruse it to our advantage.

THE ADVERTISING MAN, by Earnest Elmo Calkins. A volume of 205 pages, published by Charles Scribner's Sons, New York City. Price. $1.00.

THE NEWSPAPER MAN, by Talcott Williams, Director of School of Journalism, Columbia University. A book of 209 pages, published by Charles Scribner's Sons. Price, $1.00.

THESE books are part of Scribner's vocational series, and, as might be expected, are designed to guide either a young man or woman seeking a profession or a field of life work. In a general way, either calling has for its purpose the spreading of information and, possibly, the ultimate crystallizing of public opinion or desire. In each case, the writer must have a knowledge of his mother tongue, an understanding of the special requirements of his chosen calling, and the skill to present the topic treated so as to arrest and to hold the attention of the reader.

The belief prevails widely that the mere desire to write and a primary measure of facility in that direction are all that is needful to make a valuable and a successful newspaper man or advertising man. The authors have gone to some trouble to show the error of this state of mind and to make it perfectly plain that the aspirant must meet a number of distinct and very definite requirements. This is not said by way of discouragement but only to hearten the vocation hunter so that he may direct his efforts in that path which is most likely to lead him to a useful and a profitable goal.

THE NATURAL HISTORY OF CRYSTALS, by A. E. H. Tutton, D.Sc., M.A., Past President of the Mineralogical Society. A well-illustrated work of 286 pages, published by E. P. Dutton & Company, New York. Price, $5.00.

THIS volume, while it is based on the book *Crystals* published in 1911, contains so much new material that it cannot be considered a revised edition of that earlier work by the same author. As Doctor Tutton tells us in his preface: "Since the year 1911 a new outlook on the subject of crystals has been opened up by the discovery, of Dr. M. Laue, that the regularly arranged parallel planes of atoms within a crystal are capable of diffracting and reflecting X-rays, and that these diverted rays afford a direct revelation of the crystal symmetry when they are received on the usual fluorescent screen or sensitive photographic plate."

The startling announcement of this remarkable fact proved and disproved some previously accepted theories and necessitated a complete revision of the literature on the subject. The present volume, therefore, tells the story of crystals in the light of the X-ray results. It also includes all facts which the most recent investigations have brought to light bearing on the theories of crystal structure and on the chemistry and physics of solids and gives a concise account of the researches which have revealed the structure and nature of the atom. Of particular value to the student will be the appended glossary that briefly explains the technical terms used throughout the book, which is intended for the general reader more or less interested in natural science.

THE PROBLEM OF BUSINESS FORECASTING, edited by Warren M. Persons, William Trufant Foster, and Albert J. Hettinger, Jr. A book of 317 pages, published by Houghton Mifflin Company, New York. Price $4.00.

THE central theme of this work is the statistical basis for analyzing current economic problems for the purpose of making forecasts of business activities. In the various chapters, selected from addresses made at the 1923 meeting of the American Statistical Association, specialists deal with business conditions in general and in specific industries, such as transportation, agriculture, mining, manufacturing, etc.

As these problems are part and parcel of industry and trade, business men must deal with them—they must make judgments concerning the future on some statistical basis. In short, forecasts based on statistics determine nearly everything that men do today.

While the contributors to this volume do not undertake to tell precisely how to forecast, the several chapters are offered as a part of the work that must go steadily forward if statistics and methods of interpreting statistics are to become progressively more reliable for the general good.

Of the 545,000,000 bags of Portland cement used in the United States in 1923, about 10 per cent. went into the building of homes and dwelling places.

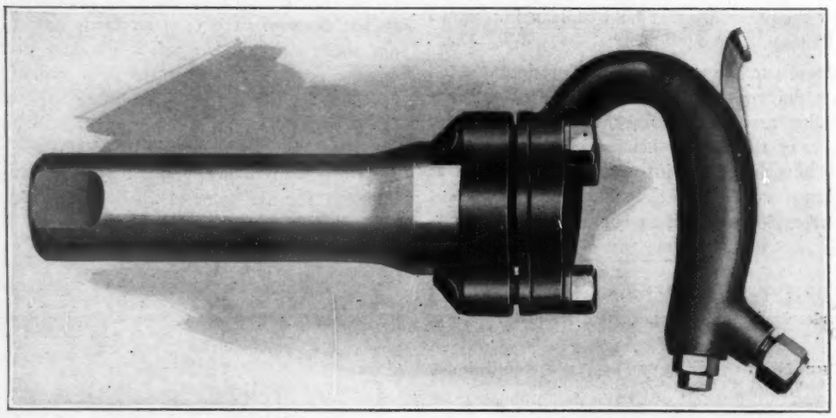
NEW HIGH-SPEED PNEUMATIC CHIPPING HAMMER

THE cleaning of steel castings and the chipping of high-carbon and alloy-steel billets require powerful, high-speed hammers, and to this end there has recently been developed by the Ingersoll-Rand Company a chipping hammer especially suited for work of this kind. The new hammer operates considerably faster than the older ones offered by the same manufacturer.

The chipper comes in two sizes, Nos. B and C, which have the following characteristics:

	No. B	No. C
Piston stroke, inches	2	2 7/16
Piston bore, inches	1⅛	1⅛
Length overall, inches	15	16
Weight, pounds	13¾	14½
Size hose connection, inches	¼	¼
Size hose recommended, inches	½	½

The main valve is a 2-diameter piece of the spool type and operates in a valve box sealed at both ends by caps. The entire mechanism is clamped, concentric with the piston bore, between the handle and the barrel. The valve is dependable in its action and sensitive to the slightest variation in hand pressure applied to the throttle lever. It is timed by a groove about the piston and by the front end of the piston. The latter is also used to govern the exhaust in that part of the hammer. This arrangement assures the necessary speed, makes for ease of holding, and likewise enables the hammer to be throttled down well.



Chipping hammer especially designed for steel castings and for billet work.

In an effort to minimize barrel breakage, all barrel sections are of heavy construction and the porting in the hammer is such that power is lost rather than gained when the chisel is played off the work. As a result, examinations of hammers of this new type, made after long periods of service, have shown the bridges to be in first-class condition.

Three handle bolts hold the handle to the barrel. This makes not only for security but also for ease of dismounting. Special attention has been given to the shape of the sand-blast-finished grip, which is of the open type and allows more room for the hand than any other chipping hammer. The throttle lever is so placed that depressing it does not strain or cramp the operator's hand; and side lugs prevent his hand from slipping over the lever when the tool is running. The throttle-valve mechanism is a combination of the piston and poppet-valve types that gives a nicety of control with freedom from leakage.

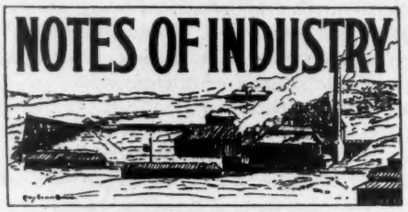
Expressed in a few words, the outstanding features claimed by the manufacturer for the new high-speed chipping hammer are: a grip with ample hand room for the operator; a neat-appearing tool that is easy to hold and to repair; excellent throttling; good balance; and rigid construction without additional weight. In fact, every wearing part is made of special steel, heat treated, and ground, and was designed and built with the idea of making it as nearly unbreakable as possible.

COMPRESSED AIR IN THE DRYDOCK

THE underwater plating of ocean-going craft frequently requires cleaning or scouring and painting. The former operation is necesssary to remove barnacles and other marine growths, which so inveterately attach themselves, and the latter to discourage such accumulations and to give the bottoms a smooth surface so that ships can glide more easily through the water.

To save sailing time and to minimize drydock charges this work must be done quickly. Therefore, wire brushes and paint sprayers, operated by compressed air, are largely employed for this purpose. English authorities claim that the use of compressed air, as compared with hand methods, cuts down the labor by 75 per cent. and the amount of paint required by 50 per cent.

In a mill at Germantown, Ill., a very simple device is employed to separate bits of metal from screenings on their way to the grinder. The flow, at the rate of 100 pounds per hour, is down an inclined spout at the lower end of which and to one side is set up a baffle board. As the material comes down the spout, a continuous current of air blows the lighter substance upward so that it passes over the baffle board, while the heavier particles fall in front of it and are detained where they can do no damage.



The water supply for the cities of Grand Forks and South Grand Forks, N. D., is taken from the Red River, which is so low as to endanger the service in the winter not because of a scarcity of water but on account of the freezing up of the intake. To obviate this, it has become necessary to build a dam, ten feet high, at considerable cost.

The world's production of refined nickel averages about 60,000,000 pounds a year, and 90 per cent. of the total comes from Canadian deposits.

India's iron and steel industry, which has been developed during the last few years, is making rapid strides. Large deposits of iron ore of excellent quality are found there, as well as sufficient quantities of flux and coal, the latter having fair heating value. It is estimated that during 1923, India's production of pig iron, including ferro-alloys, amounted to 450,000 long tons—an increase of 100,000 tons over the preceding year, and that her output of iron ore was proportionately augmented.

During the year ending June 30, 1924, about 1,432,109,373 pounds of coffee, valued at $207,048,301, was imported into the United States—reaching the highest level in the history of the coffee trade of the country. It would seem as though we are getting to be a nation of coffee drinkers, as the per capita consumption has of late years been growing steadily. It now averages 12.47 pounds annually as against 10.97 pounds in 1922 and 11.57 pounds in 1923.

Surprising though it may seem to us, it is only at this late date that the municipality of Vienna, the capital of Austria, is conducting a campaign to educate the public to use gas for cooking and heating purposes. That the substitution of gas for coal is looked upon with favor is proved by the fact that since the beginning of the year gas piping has been installed in 34,519 Viennese homes.

Aluminum-bronze is a non-ferrous metal which has lately attained considerable commercial importance. Its outstanding property is resistance to corrosion, and it also combines hardness with strength. It was said by Mr. W. M. Corse, during a lecture at the Wembley Exhibition, that the largest single use of aluminum-bronze is for worm wheels in motor trucks, and that 11,000,000 pounds of the material was utilized for that purpose in the last few years.

COMPRESSED AIR FOR THE COMBUSTION OF GAS

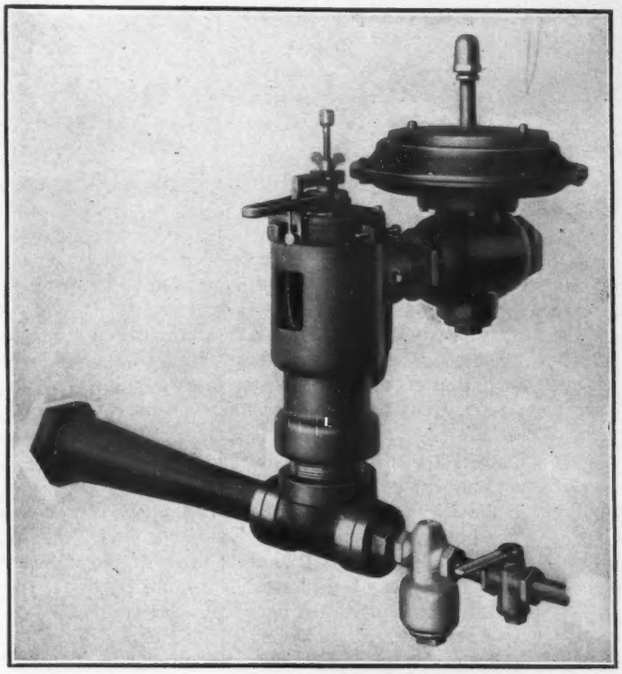
FOR the proper combustion of gas, from four to ten parts of air to one of gas are required, depending upon the calorific value of the fuel. For instance, city gas ordinarily calls for from four to six parts of air, while natural gas sometimes needs as much as ten parts. The air necessary for combustion is usually supplied by small centrifugal or positive pressure blowers at pressures ranging from a few ounces to a pound or more per square inch. Such installations are in general use throughout the country for firing, annealing, hardening, tempering, forging, and metal-melting furnace, and for a great variety of other purposes.

However, there has recently been devised an automatic gas and air proportioning device, known as the McKee Proportional Mixer, that makes use of compressed air to induce combustion and which has the added advantage of controlling the flow of both gas and compressed air by the manipulation of a single valve. The mixer is simple in construction and consists of a special regulator or governor for reducing the line pressure of the gas to atmospheric pressure, of a valve which admits gas from the line and air from the atmosphere in the desired proportions, and of a special injector with a diverging sleeve or pressure tube. A small stream of compressed air is forced through a minute orifice into the injector and brought to the proper air-gas ratio by the admixture of a small amount of gas, which is by-passed around the proportioning valve.

The high-pressure air, thoroughly mixed with the right amount of gas, passes through the injector at high velocity, producing a suction on the main part of the proportioning valve. As the handle controlling the flow is moved to the "open" position, the proper quantities of gas and air are admitted—gas through a rectangular opening and air through an opening carefully calibrated in a shape to correct for the varying resistance of the valve and for other errors. The proportions can be readily changed to handle gases differing in calorific value. Even should the proportioning valve be closed entirely, a perfect admixture of gas and compressed air would still be passing to the burners. The operation of the device does not depend on furnace back pressure; and the unit is adapted for use with automatic temperature control devices. High-mixture pressures are easily obtained.

The first essential to perfect combustion is that of maintaining the correct mixture of air and gas for the work in hand. This ratio may vary from an excess of a fraction of 1 per cent. of gas—to effect the proper reducing flame for metal melting or to prevent scaling of pots in pot furnaces—to a neutral or even oxidizing flame for other purposes. But, whatever the proportions may be, they should be maintained because an over supply of gas is wasteful due to incomplete combustion, aside from the fact that it may do harm. Flame adjustments are automatically made: unskilled workmen do not have to be relied upon to juggle valves to regulate the flame.

The employment of compressed air to induce combustion is of distinct advantage. A furnace can be put in operation without installing auxiliary blower equipment. Compressed air makes for flexibility as far as mixture pressure—the pressure of the air-gas mixture behind the burners—is concerned. A trifling change in the size of the orifice in the injector serves to step up the mixture pressure and to cause a proportionate increase in the consumption of gas. There are many cases where a high-mixture pressure is desirable.



High-pressure proportional mixer which controls the flow of gas and air fed to annealing, hardening, tempering, forging, and a variety of other furnaces.

As most shops and factories in which the proportional mixer would be of service already use compressed air for various purposes it is generally not necessary to make provision for an extra supply, as but little air is needed—only from 5 to about 15 per cent. of the total amount required for combustion. But, even where compressed air is not available, it has under circumstances been found profitable to install a unit for the single purpose of furnishing air for the combustion of gas in a battery of furnaces.

ELECTROMETER TO MEASURE HIGH VOLTAGES

THE transmission of electric energy over long distances is an outstanding feature of American economic development, especially in the South and along the Pacific Coast. As the distance increases, higher voltages must be used to avoid prohibitively large investments in copper or aluminum for the line wires. On May 6, 1923, one of the Big Creek power plants in California changed over a line from 150,000 to 220,000 volts, thereby setting a new high record in operating voltages.

While the outstanding item of expense in low-voltage systems is conducting material, usually copper, in the case of high-voltage systems, on the other hand, it is insulating material. Not only that, but the performance of the insulation is of vital importance as regards continuity of service. Methods of measuring high voltages are, therefore, essential in order that suitable tests may be applied to the insulation.

Facilities at the Bureau of Standards for the accurate measurement of voltage are now limited to 30,000 volts. To extend this range, a large absolute electrometer is now under construction. This instrument has been designed for an upper limit of 250,000 volts. When completed, the bureau expects to be in a position to check the accuracy of commercial devices used to measure present-day high voltages.

SULPHUR-IMPREGNATED SANDSTONE

IN our July issue of the current year there was a short account of some experiments conducted by the United States Bureau of Standards with sulphur-impregnated sandstone. As some of our readers were very much interested in this work, the following additional information just given out by the same Government bureau is worth publishing.

"The tests showed that the strength of the stone can be greatly increased by a few hours immersion in molten sulphur, and that porous materials are rendered practically watertight. This indicated the possibility of a commercial application of the process; and considerable interest was manifested from various sources.

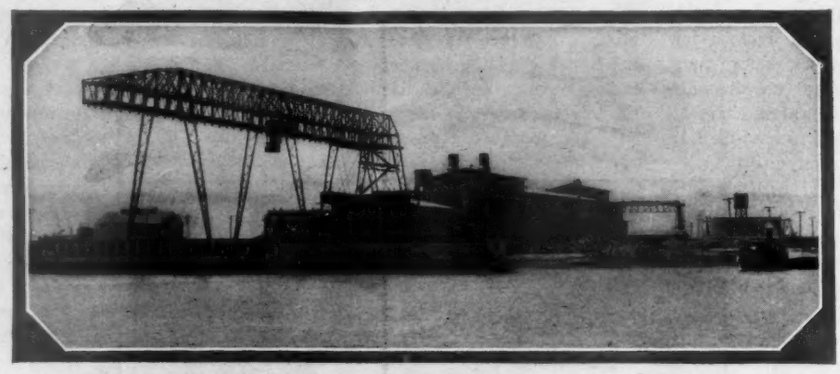
"A further study of the effect of the treatment has brought to light the fact that some sandstones cannot safely be treated in this way because they decay rapidly under moisture conditions. Until more is known concerning the chemical action which appears to take place between the sulphur and certain constituents of the stone, the bureau believes that the process should not be tried for commercial purposes."

The Listowell and Ballyshannon railway in County Kerry, Ireland, built in 1888, is to be discontinued, a fact of little interest to us except that the road is the only representative of a peculiar monorail system. The permanent way is 9¾ miles long and consists of trestles, 3 feet high, supporting a single line of rail. Light guiding rails are fixed on each side of the trestles near the bottom. The locomotive and the cars straddle the main rail, which carries the whole weight, being kept balanced by light contact with the guide rails mentioned. The road, which connects a town on another line with a seaside resort at the mouth of the Shannon, was built in nine months at very low cost, but it has never been a financial success.

OYSTER SHELLS FURNISH LIME FOR CEMENT

PORTLAND cement, as most of us know, is a compound of lime, silica, and alumina. Now the oyster shell, so we are told, is pure lime—the principal ingredient in the manufacture of cement. With this in mind, enterprising Californians have built a plant at Redwood City, on San Francisco Bay, for the purpose of converting oyster shells into Portland cement.

The shells, which are to be had near by in great abundance, are reclaimed by means of specially designed suction dredges and brought in barges to the unloading wharf of the plant. Thence a large traveling crane, shown in one of the accompanying illustrations, delivers the raw material to grinding mills. From there the stuff passes into big concrete slurry tanks, of which there are fifteen, where it is analyzed before the proper amount of water and other necessary constituents are added. Then the contents are pumped from one tank into another and into so-called blending tanks until the right mixture is obtained. To assure a thorough admixture of the mass, compressed air agitation is relied upon at this stage of the process.



Where oyster shells are used in the making of Portland cement.

The "slurry," as it is called, is now ready for the kilns—large cylinders, lined with fire brick, that are slightly tilted and turned slowly, making one revolution in 90 seconds. In its rolling progress through the kiln the material is first dried, then heated, and, as it approaches the lower end, fused into clinker which drops into similar but smaller steel cylinders. Set at right angles to the inner surfaces of these cylinders, which are also rotated, are little racks which alternately pick up and drop the clinker for the purpose of cooling it. With this work done, the clinker, which is now in a state for pulverizing, is carried by a conveyer to a storage pile.

The oyster shells used are garnered from beds covering 30,000 acres, and the engineers of the company in question estimate that there is enough raw material available to supply the plant for several hundred years.

According to recent estimates, there are now about 140 miles of underground workings in the gold mines of northern Ontario. The latter are being developed to such extent that those workings are being added to at the rate of about two miles a month.

CLEAR FUSED QUARTZ

MANY MISLEADING statements have latterly been printed regarding clear fused quartz, and we are, therefore, extracting from one of the *Research Narratives*, recently issued by Engineering Foundation, which deals with this subject.

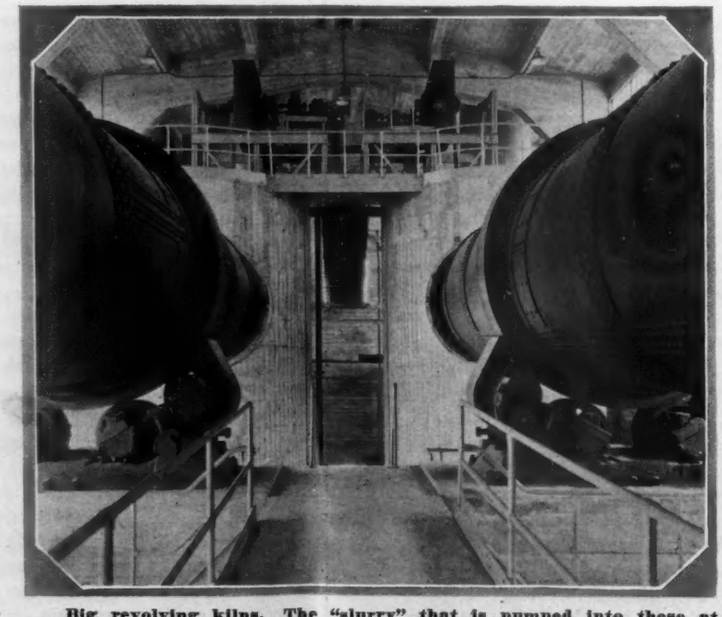
Clear fused quartz is a glass-like substance of superior physical qualities which promises to have numerous useful applications. The product is the outcome of nine years of persistent scientific research, and is due to a process which has been developed to a stage whereby large quantities of the material, in relatively big masses, can be made upon a commercial scale.

According to the Engineering Foundation, not only important industries but also advances in the sciences and the arts are favorably affected by this accomplishment. As silicon dioxide constitutes no less than three-fifths of the outer ten miles of the earth's crust, the only evident limitations to the output of clear fused quartz are mechanical ones, and these are mostly in the size, strength, and operation of equipment for handling the raw materials in bulk and in manufacturing the commodity on a large scale. Naturally, the cost of these facilities has to be taken into account.

To produce clear fused quartz, the clean natural crystals, which are of small size, are packed as densely as possible in a graphite or carbon crucible, so that in the inevitable cracking of the crystals as the temperature rises the parts cannot separate and permit gas, which may be present in small quantities, to enter the crevices and to form bubbles. The quartz is heated in a modified vacuum furnace to a melting temperature of 3,272°F. This must be done as quickly as possible—in 45 minutes or less, while the pressure is kept as low as practicable.

The resulting transparent slugs, which may contain a few small bubbles, are placed in another graphite crucible suspended in a vertical, carbon tube furnace equipped with a weighted graphite piston that closely fits the crucible. The slugs are heated to a temperature sufficient to induce fusion; the bubbles mostly collapse by reason of the weight; and the latter causes the quartz to extrude through the bottom of the crucible and to take the form of rods or tubes, as desired.

When large blocks of fused quartz are to be made, a vacuum furnace is used which is capable of withstanding very high pressures. As soon as the quartz has fused, the vacuum valve is closed and the pressure upon the plastic mass is raised. In this manner it is feasible to produce large cubes of quartz freer from bubbles than are many kinds of the best optical glass.



Big revolving kilns. The "slurry" that is pumped into these at one end comes out at the other in the form of clinker.

It appears from tabulated records of the State of Wisconsin for 1922-23, that straight-road accidents outnumbered all others two to one. Curves, hills, and railroad crossings make a driver more or less cautious; but a straight, smooth road apparently invites him to "step on the gas." Out of 2,981 road accidents reported, 2,044 occurred on straight roads and only 937 in all other places. Reckless driving is given as the cause for 1,628 of the accidents.

According to B. R. Hawley, in *Power*, there are now 600,000 brake horse-power in Diesel engines in use, and the figure is being increased at the rate of 90,000 per year. About 99 per cent. of all the engines of this type installed are still in commission.